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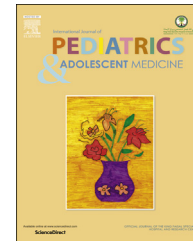


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## INVITED REVIEW

# Building brains, forging futures: the pediatrician's role



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**Abstract** Recent leaps in the understanding of early brain growth and child development provide us with scientific underpinnings for strategies to improve child health outcomes. Genetic, environmental, and behavioral factors impact the growing child and have a profound impact on lifelong health and function. Recent advances in knowledge concerning the biologic underpinnings of brain development provide a better understanding upon which to base interventions. All growing children experience stress. However, if children are stressed in a manner that exceeds their coping capability, the stress is considered toxic. Toxic stress can impede the cognitive and social emotional growth of the developing brain. Pediatricians have the opportunity to intervene through screening for families at risk, supporting optimal parenting, and linking in a team fashion with other providers of care for young children to support development.

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## 1. Introduction

Enhancing the optimal development of the growing child has always been a focus for the profession of pediatrics. In

1967, former American Surgeon General Dr. Julius Richmond defined child development as “the basic science of pediatrics” [1]. The study of the acquisition of language, movement, and cognition differentiates pediatrics from all other medical specialties. The role of the pediatrician in guiding families to shape development, especially early in brain development, continues to be essential. This charge to promote optimal development broadens a pediatrician's attention to factors outside the traditional boundaries of medicine, as development is determined by a child's genetics, environment, family strengths and challenges, and both formal and informal social capital.

Development is an evolutionary process that begins with genetic endowment of the developing fetus and then is

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influenced by a broad range of environmental factors. Beginning prenatally, continuing through infancy, and extending into childhood and beyond, development is driven by an ongoing interaction between biology (genetic predispositions) and ecology (the social and physical environment). Factors that either promote or undermine early human development have been identified and reveal the interaction of genetic and environmental factors in building brain architecture. Brain development can be impeded by many factors, including war, socioeconomic distress, parental dysfunction, exposure to domestic violence, and media exposure in young children. The dynamic process of brain development sets the life-course trajectory for an individual; in turn, everything from that child's education achievement to economic stability to health behaviors to chronic disease stems from this "dance" of genetics and experience.

## 2. A collective responsibility

The American Academy of Pediatrics (AAP) has long recognized the importance of a focus on brain development. Health equity is a key theme in the strategic plan of the AAP. All children, regardless of family, nationality, socioeconomic status, or other variables, should be given the opportunity for optimal development. Written in to the American Academy of Pediatrics strategic plan [2] in 2010 is a specific focus on the role we pediatricians play, through our patient contact, advocacy, and program development, on enhancing early brain and child development for children everywhere. The pediatrician as a child advocate has a strong role to play in working with other professional, government, and social groups. It is known that interventions early in life are more cost effective. Noted health economist James Heckman has developed his famous equation suggesting that investing in educational and developmental resources for disadvantaged families, promoting cognitive and social skills in preschool children, and sustaining these early efforts with effective education results in more capable and productive citizens that pay dividends to society for generations to come [3].

## 3. Point of service opportunities

Pediatric visits are opportunities for developmental enhancement. Screening and surveillance, family engagement, anticipatory guidance, and the creation of therapeutic alliances with families are part of the traditional pediatric encounter. Unfortunately, within the context of busy pediatric patient encounters, opportunities for developmental promotion and surveillance are often missed. Pediatricians have a role in the identification of those children at high risk for poor development, providing positive parenting support for all families to assist them with development, and providing referrals for additional support when necessary. However, too often child health professionals are not succeeding. In many societies, including developed ones, far too many children are left behind. In some areas in America up to 30 percent of youngsters are not succeeding in school by the 3rd grade. High school completion rates are unacceptable and the

behavioral health consequences, oppositional behaviors, and mental health consequences as well as the long term impact on worker productivity result in significant losses of potential and increased long term financial costs to society.

## 4. Plasticity

Brain growth begins with a tremendous proliferation of neuronal connections, connections that are each little experiments with the environment. As the infant grows and matures, pruning of these connections begins as the cerebrum sorts out which connections are useful and which are not. The ability to change the physical structure of the brain in response to need early in life is referred to as plasticity as the brain is plastic and able to respond to the surrounding environment. The propensity for plasticity in the brain is not permanent; it changes over time and is related to the age and development of the child. Windows of opportunities that open and close for development exist in the evolving organism. Without the appropriate stimulation at the right time, the developing cerebrum is impeded in engendering the appropriate connections for success in the future.

We know the developing brain responds to stress. Some types of stress lead to healthy routines such as learning right from wrong and building resilience. Toxic stress is defined as prolonged exposure to adversity (for example neglect, food insecurity, and violence) that causes lasting damage to the developing brain.

Stress of all sorts is essential to the growth and development of the infant human organism. Our immune systems develop as they are exposed to stresses in the microbial environment. Our gastrointestinal systems learn to eat and digest the foods of our cultures, and the developing child learns to accommodate and manage the psychological and intellectual milieu in which they exist. Similar stress and response activities occur in the brain. Children sometimes recognize new situations as stressful, and reach out to those around them to help them learn to accommodate. Caring caregivers provide the emotional support, and the modeling that is essential to the development of coping skills in the face of new adversities. However, in situations in which there is no capable caregiver, no one who is able to provide the needed comfort and guidance, or when the stress is of such magnitude, such as exposure to excessive violence, trauma, or catastrophes, all sorts long lasting developmental consequences occur. In these situations the stress becomes toxic [4]. Toxic stress is the result of overwhelming adversity that exceeds the ability of the growing infant's brain to cope and learn. It has a negative impact on cerebral architecture through the disruption of the neuronal architecture. It adversely effects the development of regulatory functions and can lead to permanent cognitive and social-emotional disability. These changes potentially impact future behavior, both internalizing and externalizing, and result in physiologic disruptions with life-long impacts on the health of the developing individual. The lifelong consequences are substantial and lead to higher levels of chronic disease. The impact of toxic stress on the long term function of the developing child underlies the cost effectiveness of intervening earlier in life [5].

This negative impact of toxic stress not only undermines cognitive ability in the individual, but is also encoded into the human organism through epigenetic processes, thereby influencing succeeding generations. Forces that support early brain and child development are like a three legged stool, these forces being:

- The genetic, prenatal, and neuro-developmental capabilities with which the infant is endowed.
- The socioeconomic environment within which the child is nurtured.
- The attachment and relationship patterns that develop to connect the young child to the external world.

Early brain development is sometimes confused by the public and policy makers as exclusively the realm of early cognition, such as literacy and a framework for mathematical skills. However, the development of appropriate social emotional skills is just as important to the human infant, including:

- The ability to modulate one's behavior in group environments, to have consistent emotional experiences.
- To have positive two way interpersonal relationships, to reciprocate, and have positive social exchanges.
- To develop a sense of self, an ego and confidence in mastering new challenges.
- To acquire an interest and curiosity about the surrounding environment, and an interest in lifelong learning.
- To learn to sustain attention and to focus over time on the task at hand.

These are the basic relational skills that young children require if they are to be capable of success in school, lifelong learning and of future service to society. Without the appropriate development of these skills, children are at risk for suffering from difficulty with learning, disturbances in regulation, greater internalization and externalization problems with behavior, and increases in risk taking [6]. The development of these relationship skills are adversely affected in environments overly rich with stimulation from the media and in families overwhelmed by poverty, or substance abuse or domestic violence, or with limited social capital.

As the role of the pediatric medical office evolves to translate the science of brain development to the day to day operations of a primary care practice, new processes are required. The opportunities for impacting brain development positively are thus interventions focused on the children and their characteristics, and assistance for families that improves their functioning. Programs that alleviate poverty in children, focus on domestic violence prevention and child abuse, or link families to both informal and formal sources of support all help prevent toxic stress.

## 5. Psychosocial-socioeconomic screening

Children's health facilities provide a unique opportunity to screen families for risk factors that may impede optimal developmental support. Screening occurs within the

broader context of taking the family and social history and the opportunity that the health care provider has to interact and relate to families over time. Repeated visits to the pediatric office provide the opportunity for developmental surveillance, and re-assessment as to how the child is growing. The trusting relationships between the child health providers and the families lead to a buffering influence against toxic stress and provide a framework upon which screening becomes acceptable. Family behavioral health, domestic violence, food insecurity, and poor social capital or socioeconomic distress can be identified within the pediatric office. These factors are more readily identified if there is a structured screening protocol in place. Screening should be used cautiously so that it does not raise unnecessary concern or become stigmatizing. If the screen is "scored" and the score is used as a basis for referral, the screen should be adequately validated in the population group in which it is being utilized. However, in clinical medicine, non-validated screens have a role as facilitators for structured history taking, in which pertinent positive responses are considered and discussed with the patient and family.

The Kemper-Kelleher tool is a prototype for comprehensive screening. It focuses on family health habits, substance abuse issues, parental history, and social capital, all appropriate areas of interest for child health professionals interested in development [7]. However, this tool is lengthy and difficult to use in many clinical situations. The SEEK (Safe Environment for Every Kid) questionnaire is specifically designed for busy office settings and has demonstrated use in supporting families at risk. The SEEK questionnaire also identifies domestic violence, socioeconomic distress and food insecurity as well as maternal mental illness [8]. A tool such as the SEEK questionnaire, if implemented universally, could identify both parents in need of caregiver support and children at risk for toxic stress. Another screening tool, the Beaufort Stress Index, is not validated but has been found to be a useful tool in taking histories for family risk factors [9]. Both the SEEK questionnaire and the Beaufort Stress Index are quick and easy to use and fit into the busy routines of pediatric clinics. The American Academy of Pediatrics' Connected Kids program suggests screening questions for families for child health care providers focused on issues of potential family stress and social capital [10]. Targeted screens such as the Women Abuse Screening Tool; the Women's Experience with Battering (WEB) scale; the Abuse Assessment Screen (AAS); or HITS (hurt, insult, threaten, scream) may be helpful if intimate partner violence is suspected [7]. The use of these latter tools requires professional experience and training, but could be facilitated by auxiliary personnel such as nurses. The identification and triage of positive screens could enable an efficient workflow process. There are additional screens, and some in development, that may also have utility in the pediatric clinical encounter.

## 6. "Immunization" against developmental and behavioral disorders

Pediatricians have carved out the promotion of early brain and child development as a key component of their

approach to well-child care. Parents want more assistance with supporting the growth and development of their children. Much of the AAP's Bright Futures program is focused on monitoring and enhancing the intellectual and mental growth of the developing child [11]. Bright Futures is a well-child care regimen that focuses on development and positive approaches to parenting and is used as the basis for prevention in pediatrics. Bright Futures specifically guides pediatricians, as well as other professionals and policy makers, at age-appropriate intervals in a rich integrated approach to the promotion of development [12].

"Immunization" against developmental and behavioral disorders is a primary function of anticipatory guidance to families by pediatric health care professionals. Skilled clinicians become adept at recognizing that the interaction between the parent and child is a window into the ability of the parent to optimize their child's development [13]. Noticing differences between the parent who is actively engaged with her child and the parent who is not interacting (i.e., a parent talking to their infant vs. a parent texting on their phone while the infant is in a car seat) and then taking the opportunity to reinforce the positive relationship of the first parent and investigate the lack of interaction with the second parent are key skills for pediatric clinicians. When anticipatory guidance alone is insufficient, the pediatric visit is an opportunity for referral to further family support or home visiting services. Pediatric clinicians also can promote language and communication development by promoting the Five R's: Reading—every day; Rhyming—playing and cuddling; Routines—so children know what to expect from us, and what is expected of them; Rewards—including praise for everyday successes and Relationship—reciprocal and nurturing, the foundation of healthy development. Many families need support in the basics of stimulating infant brains and understanding the importance of positive face to face interaction, of smiling at their newborn, of a language-rich environment, and of modeling positive interpersonal relationships.

Specifically designed for busy pediatric offices, Reach Out and Read is a program where books are provided to young children during well visits. Reach Out and Read [14] is one of the most studied interventions, teaching not only the foundation of early literacy but providing the opportunity for the parent and child to have a positive shared experience. Clinicians talk about the importance of reading, parents are encouraged to start reading and interacting with their children, and reading is modeled by volunteers in a pediatric waiting room. Pediatric clinicians can promote language-rich environments by modeling such behavior and discussing "serve and return" interactions between young children and the adults that care for them. Teaching positive discipline techniques and the normal independent behavior of the developing toddler can assist parents with providing the appropriate developmental cues.

Providing information on appropriate media exposure and the potential impact of television exposure is a valuable to parents. The potential negative consequences of media on future learning and development are a major concern in any discussion of early brain development. The American Academy of Pediatrics recommends no exposure to television prior to two years of age and limiting the quantity of screen time in older pediatric age groups [15].

## 7. Partnership with early childhood professionals in the care of at-risk families

Formal support for families is not limited to the pediatric office. To be most effective, pediatric clinicians should seek opportunities to partner with other early childhood professionals in the ongoing promotion, family support, and monitoring of their patients' development and behavior [16]. Knowledge of home visitation programs [17], early education and child care facilities, nutrition support and social services increases the capabilities of the clinician to address family support and education needs [18]. Home visiting programs specifically linked to pediatric outpatient clinics so that both professionals can work together with parents in promoting optimal development have great potential [19]. Working with agencies focused on population health, specifically the needs of small children, lays the framework for optimal development. Identifying nutrition/living condition needs and performing environmental and safety assessments and working with parents to ensure a supportive environment are important to the developing brain. Focusing on health issues with the caregivers, especially mental health conditions and depression, improves the capability of the family to enhance cerebral growth. In-office partnerships with on-site mental health services, lactation consultants, care managers, home visitors, and others enhance the pediatric office.

One such partnership, Healthy Steps [20], provides developmental specialists with more time to provide family support and anticipatory guidance in the health care environment. The Healthy Steps developmental specialists free up the clinicians time for medical issues, but provide families with the advice and support they need to be effective in minimizing toxic stress and promoting development. Helping and linking families with appropriate quality day-care arrangements can be of great assistance to young families. Pediatricians should be resources for their local early education and childcare facilities, and can help educate families as to the features essential for optimal development. Perhaps most important is the capability of the pediatric health care facility to identify those children who have developing delays. Pediatric outpatient care is an optimal place to serve as the "headquarters" for the evaluation of children who have been identified as having developmental delays. When delays are identified, children with potential delays should be linked to early intervention services, early childhood special education services, and therapy as indicated.

## 8. Opportunities to impact early brain development trajectories

We as child health care providers have an opportunity to reach out and promote opportunities for enhancing development. We can do that by minimizing toxic stress with programs focused on socioeconomic distress, familial substance abuse, domestic violence, and maternal depression. We can promote supportive relationships for families through enhancing social capital and working with others including home visitors. We can provide an environment for healthy development, ensuring the absence of toxins such

as lead, promoting optimal nutrition, teaching families basic media literacy and the impact of television on the developing brain, and preventing catastrophic disease through pediatric immunizations and monitoring for potential disease. We can help families with development enhancing activities such as teaching the importance of positive face to face interactions, smiling at your newborn, providing a language-rich environment, and modeling positive interpersonal relationships with parents. These positive parent opportunities are well documented in improving early outcomes. Pediatric team-based care has an evolving role in supporting early brain development. The partnership between pediatricians, office staff, early childhood professionals, and families can build an environment that optimizes development for our children by building on our new understanding of early brain growth. The pediatric outpatient facility of the future could offer more than the early identification of concerns and timely referral to available programs. Enhanced collaboration between pediatricians and community-based agencies could test intervention strategies rather than simply improving coordination among existing services [21]. Interventions that strengthen the capacity of families and communities to protect young children from the disruptive effects of toxic stress will promote healthier brain development, enhanced physical and mental wellbeing, and a productive, educated workforce.

### Conflict of interest

None.

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