CHILDREN

Contents

Stages of Development and Growth

H Hayden-Wade and L K Leslie, Children's Hospital of San Diego, San Diego, CA, USA

Introduction

This section provides a brief overview of children's (defined age 0–18 years) growth and stages of development. In particular, this section will elucidate general patterns of growth (including weight, height, head circumference, brain growth, and puberty) and the acquisition of developmental milestones from childhood through adolescence.

A variety of important forensic issues exist in relation to child growth and development and are discussed in more detail in other selections in this volume, including autopsy.

Growth

Physical Growth

Weight In general, weight increases significantly during the first year and then slows through adolescence. Major weight-related milestones may be tracked from birth through adolescence as follows.

liability many police forces regulate the use of chemical crowd control agents by establishing policies to guide their use. One example is the "ladder of force." This continuum describes the sequential increase in force and is used to help guide the use of an appropriate method of restraint. Words are used first, followed by more defensive actions such as chemical agents, batons, and finally firearms. It is important to note that some individuals may require more than one exposure to the agent before the optimum effect is achieved or if the agent has been exposed to extreme environmental conditions or has not been replaced in a timely manner. Use of these agents should be monitored and formal reports filed when they are used. Like all equipment, chemical agents should be stored appropriately and replaced according to the manufacturer's guidelines. These agents afford control of violent offenders with much less risk to life and limb than do firearms, explosives, and battering.

See Also

Injuries and Deaths During Police Operations: Shootings During Police Stops and Arrests; **Restraint Techniques, Injuries and Death**

Further Reading

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Growth

Physical Growth

Weight In general, weight increases significantly during the first year and then slows through adolescence. Major weight-related milestones may be tracked from birth through adolescence as follows.

After an initial period of weight loss during the immediate postnatal period, birth weight is regained between the 10th and 14th postnatal day. Between the ages of 2 weeks and 6 months, the average weight gain equals 20 g (0.71 oz) per day and decreases between 6 and 12 months to 15 g (0.53 oz) per day. Across the second year, weight gain slows considerably, with the average monthly weight gain at 25 kg (8.82 oz or 0.55 lb). A quick rule of thumb for the first 2 years of life is that birth weight doubles by 4 months, triples at 12 months, and quadruples at 24 months. After age 2, average weight gain until adolescence is 2.3 kg (5 lb) annually.

Length/height Rough guidelines suggest that birth length is doubled by 4 years of age and tripled by 13 years of age. By the end of the first year, birth length increases by 50%. The average height gain across year 2 is 12 cm (5 in.). From age 2 to the beginning of adolescence, the average child will grow 5 cm (2 in.) per year. Adolescence ushers in a second growth spurt with respect to length/height. In adolescence, a typical (average) maximum growth spurt for a male is 10.16 cm (4 in.), whereas, for female adolescents, their growth spurt averages 7.52 cm (3 in.) during its peak. By the end of the adolescent period, both males and females reach 99% of their adult height.

Head circumference Clinically, head circumference is routinely measured during the first 2 years of life. During this time, the brain is growing immensely and the open sutures between the bones of the skull are closing. Between birth and 2 months, the average head growth in 1 week is 0.50 cm (0.20 in.), and then slows to 0.25 cm (0.10 in.) between 2 and 6 months. The average total head circumference growth from birth to 3 months is equal to 5 cm (1.97 in.), and 4 cm (1.57 in.) average from 3 to 6 months. This trend continues to decelerate across the first year; between 6 and 9 months, head circumference increases 2 cm (0.79 in.) and between 9 and 12 months, head circumference increases only 1 cm (0.39 in.), approximately.

During the second year, a child's head growth slows (i.e., 2.5 cm or 1 in., for the entire year), although attainment of 90% of adult head size occurs by the end of that year.

Brain growth The brain, at birth, is closest to its adult size than any other organ – in fact, it is considered close to 80% of its adult weight. By age 6, a child's brain is closer to 90% of its adult weight. However, while the brain's weight does not change substantially, significant formation of brain neurons and remodeling of neuronal paths is occurring during childhood and adolescence.

The brain's development is the most rapid during the initial 2 years of life. Prenatally, 250 000 million neurons are formed per minute. Ultimately, between 100 and 200 billion neurons (nerve cells) make up the brain, and are responsible for storing and transmitting information as well as providing neurological interconnection with other neurons. Remodeling is also occurring. Neuronal paths are being remodeled consistently through dendritic branching (i.e., dendrites, or the thread-like extensions of the cytoplasm of a neuron, branch into tree-like processes, composing most of the receptive surface of a neuron) and myelinization (i.e., the process within which a lipid-rich substance coils to form a protective sheath surrounding the axon of nerve fibers to provide efficient transmission of neuronal messages across nerve fibers).

An important developmental aspect of the brain to consider in working with children involves the specific order in which the various areas of the cortex develop. The cerebral cortex, which surrounds the brain and comprises 85% of the brain's overall weight, provides the intellectual capacity that differentiates human beings from our animal counterparts. The order of development of certain areas of control within the cerebral cortex parallels the sequence of acquisition of different developmental milestones and capacities as the child matures. With respect to motoric skills, cortex development dictates a cephalocaudal progression of development, which is marked by truncal coordination at the outset, followed by mastery of the extremities. In the domain of emotional/behavioral/adaptive skills, cortex development continues to mature through adulthood; for example, the last section of the cortex to develop is the frontal lobe (responsible for thought and consciousness).

Changes associated with puberty Adolescents progress through a similar sequence of pubertal changes, although it should be noted that each adolescent varies in the timing and nature of pubertal change.

For adolescent females, the vagina and ovaries become larger, accompanied by cellular and chemical changes, followed by menstruation and ovulation. For males, the testicles enlarge, followed by sperm production. Both females and males develop pubic and underarm hair.

One can judge adolescent physical or reproductive maturity by examining these secondary sex characteristics, which mature in sequential stages, to determine the sex maturity rating (SMR). Clinicians measure

SMR on a five-point scale, with one indicating prepubertal stage and five indicating adult status. For adolescent females, the pattern and characteristics of pubic hair, as well as the form and contour of the breasts, help establish the SMR. Around SMR level 4 for breasts and SMR level 3 for pubic hair, adolescent girls experience menarche (first menstrual cycle). In boys, genital changes as well as the quantity and pattern of pubic hair determine SMR. See Tables 1 and 2 for classification ratings of sexual maturity for males and females, respectively.

Abnormalities of Growth

It is important to keep in mind that a number of medical conditions can impact one or more of these arenas of growth. In addition, several environmental factors can impact growth across population samples. For example, there has been an obesity epidemic among children living in industrialized nations; the weight trajectory information provided by the Centers for Disease Control and Prevention (CDC) only covers average, nonobese weight gain across childhood. At the other end of the spectrum lies the malnourished child, who may exhibit weight gain velocity significantly below that expected for chronological age. In the malnourished child, head circumference and height are relatively spared, especially if the malnourishment is addressed expeditiously.

Table 1 Classification of sex maturity ratings in boys

Rating	*Pubic hair*	*Penis*	*Testes*
1	None	Preadolescent	Preadolescent
2	Scanty, long, slightly pigmented	Slightly enlarged	Enlarged scrotum, pink, less smooth
3	Darker, curls, small amount	Longer	Larger
4	Adult type but less; curly, coarse	Larger, breadth increases	Larger, scrotum is darker
5	Adult pattern; spreads to inner thighs	Adult	Adult

Table 2 Classification of sex maturity ratings in girls

Rating	*Pubic hair*	*Breasts*
1	Preadolescent	Preadolescent
2	Scanty, slightly pigmented, straight, on inner part of labia	Breast elevated as small mound
3	Darker, starts to curl, increased amount	Breast and areola enlarged, no separation
4	Coarse, curly, more but less than adult	Areola and future nipple form a secondary mound
5	Adult feminine triangle; spreads to inner surface of thighs	Mature; nipple projects, and areola part of general breast shape

Measurement of Growth

Because abnormalities of growth may be the first presenting sign of a medical condition or environmental stressor, medical professionals, including forensic scientists, plot an individual child's height, weight, and head circumference on cross-sectional growth charts in order to gather statistical definitions of normality by comparing that child to others of similar age and same sex. In addition, clinicians plot growth velocity in order to determine that a child is growing at an appropriate rate with respect to weight, height, and head circumference.

The CDC growth charts were revised in May 2000 to incorporate more diverse ethnic samples as well as new body mass index (BMI) information for all children 2–20 years of age. These growth charts were originally developed by the US National Center for Health Statistics (NCHS) in 1977. (See Figure 1 for four of the most recent (2001) standardized growth charts taken from the CDC website (http://www.cdc.gov/growthcharts). Consult the website for additional charts for both boys and girls, including weight-for-stature percentiles, head circumference-for-age, and weight-for-length percentiles for birth to 36 months, and body mass index-for-age percentiles for 2–20 years.)

Development

First quantified by Arnold Gesell in 1925, child development is a dynamic, orderly, and cumulative process by which a child undergoes a series of qualitative changes in skill levels at predictable time intervals called developmental milestones. There are four generally recognized domains of development for a child: (1) motor (both gross and fine); (2) language; (3) cognition; and (4) social/behavioral/adaptive skills. Gross motor skills involve large muscle groups and are essential for skills like running, jumping, rolling, and balancing on one foot, whereas fine motor skills refer to a child's ability to manipulate items with the hands and fingers, such as holding a spoon or turning the pages of a book. Language development reflects a child's ability both to understand and express language. Cognitive skills refer to a child's ability to learn new material and solve problems. Social/emotional skills include abilities such as a child's capacity to relate to and interact with others, to self-soothe, and to self-control.

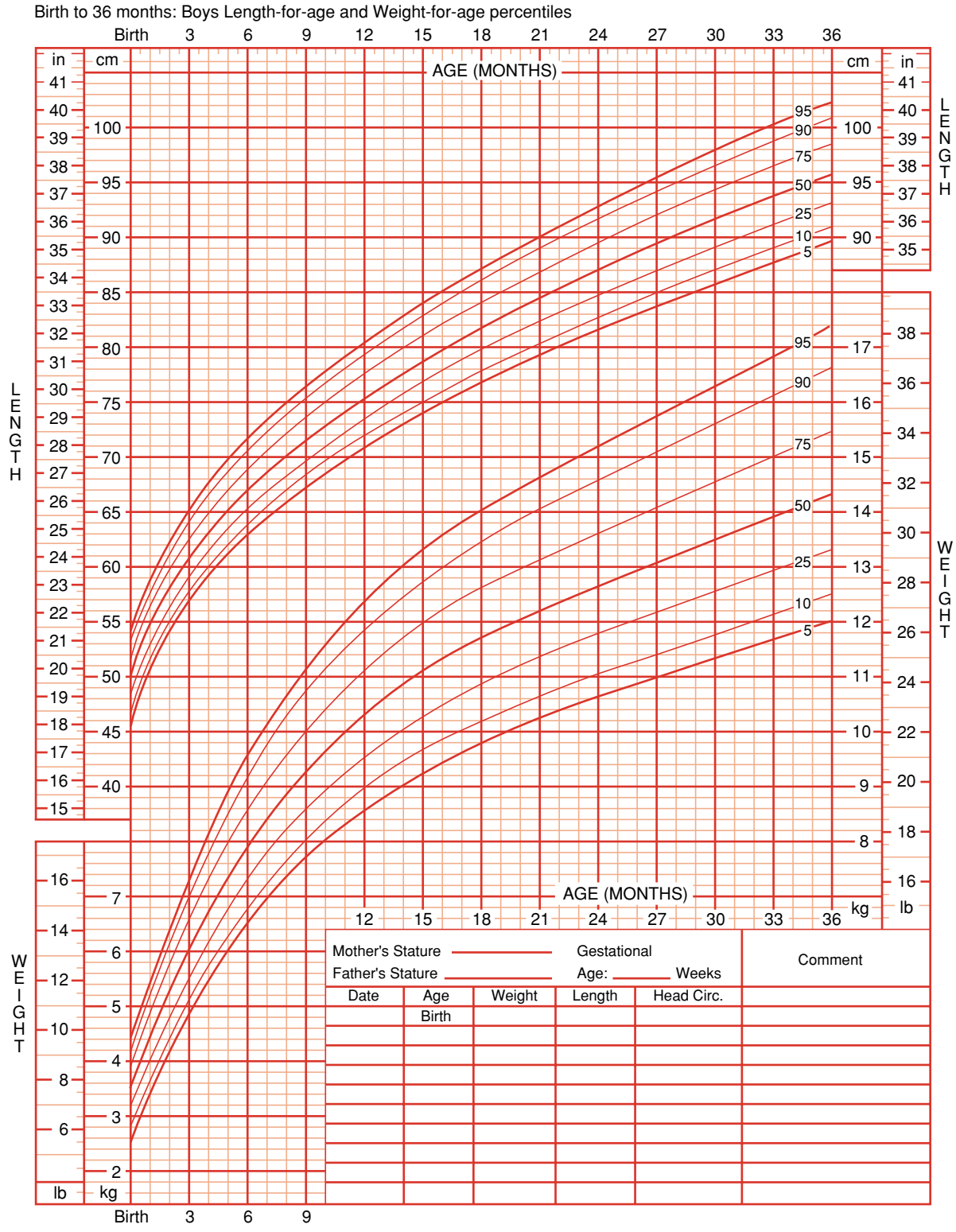

Figure 1A (continued)

Children who do not reach these developmental milestones at the predicted time intervals may have developmental delay and/or mental health problems.

Motor Development

Motor development encompasses gross motor (involving the large muscle groups) and fine motor (involving the smaller muscle groups) aspects.

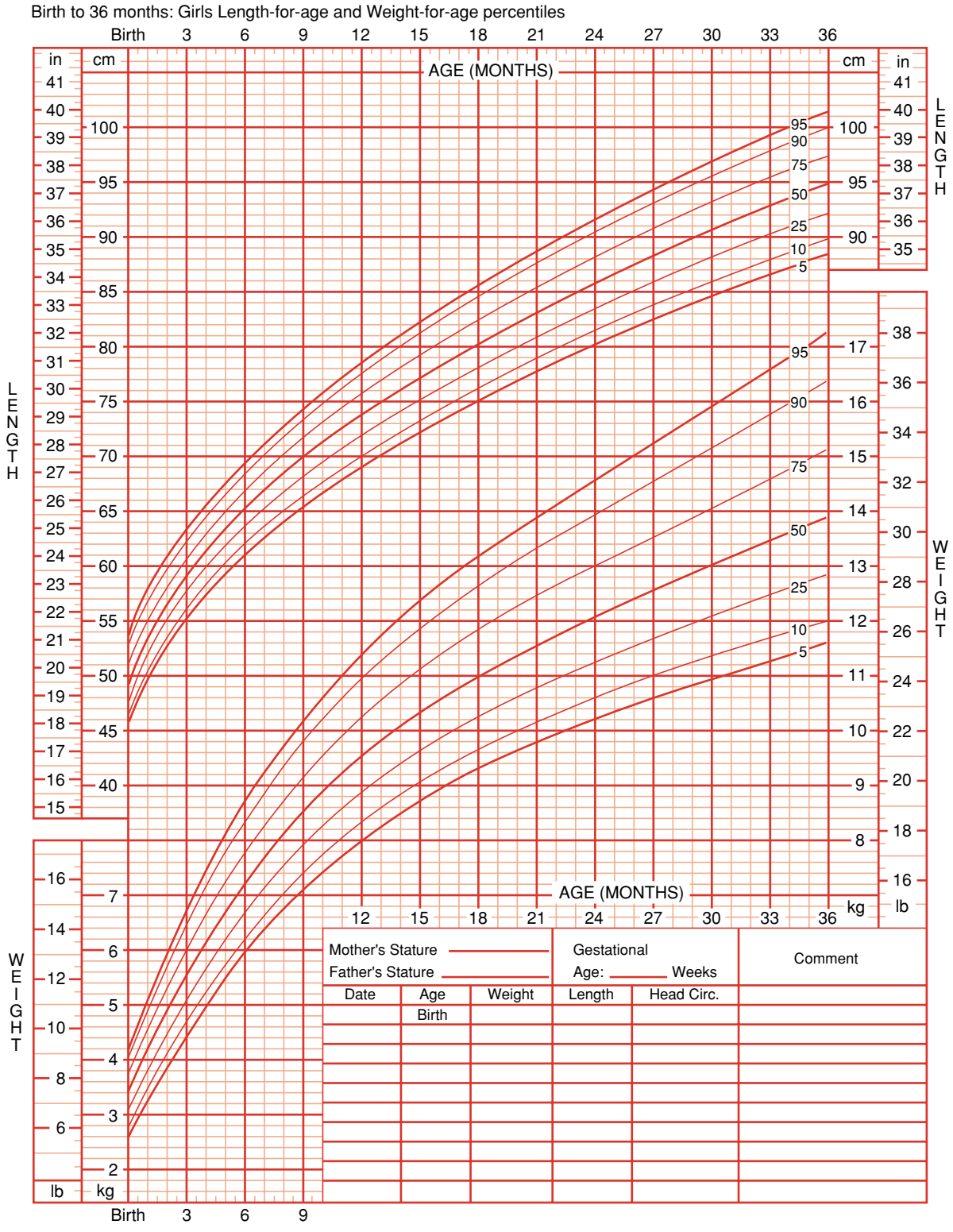

Figure 1B (continued)

Reflexes Initially, all infants display a series of primitive reflexes, which are lost as infants develop volitional movement, generalized mass activity, and ultimately specific responses. At birth, there are over 70 reflexes exhibited by infants and tested, most of which are extinguished between 2 and 12 months of age. Table 3 provides a detailed overview of 11 of these major infant reflexes.

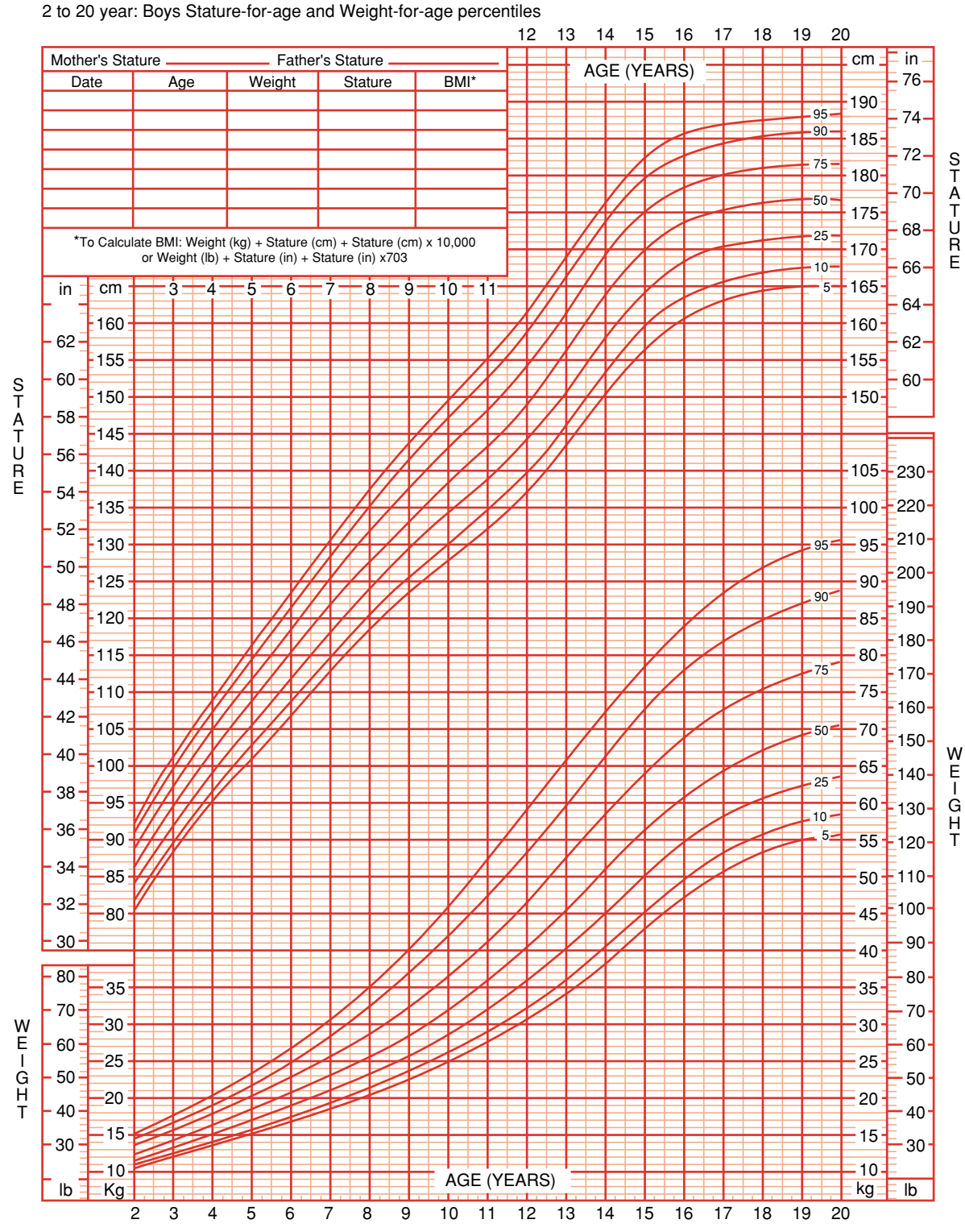

Figure 1C (continued)

Gross motor development All children pass through similar sequences of motor development, which progress along with the maturation of the central nervous system in a cephalocaudal (trunk-to-extremity ordered progression of development and control) as well as proximal-to-distal direction. Again, first cephalocaudal progression is marked by truncal coordination, followed by the child's mastery of

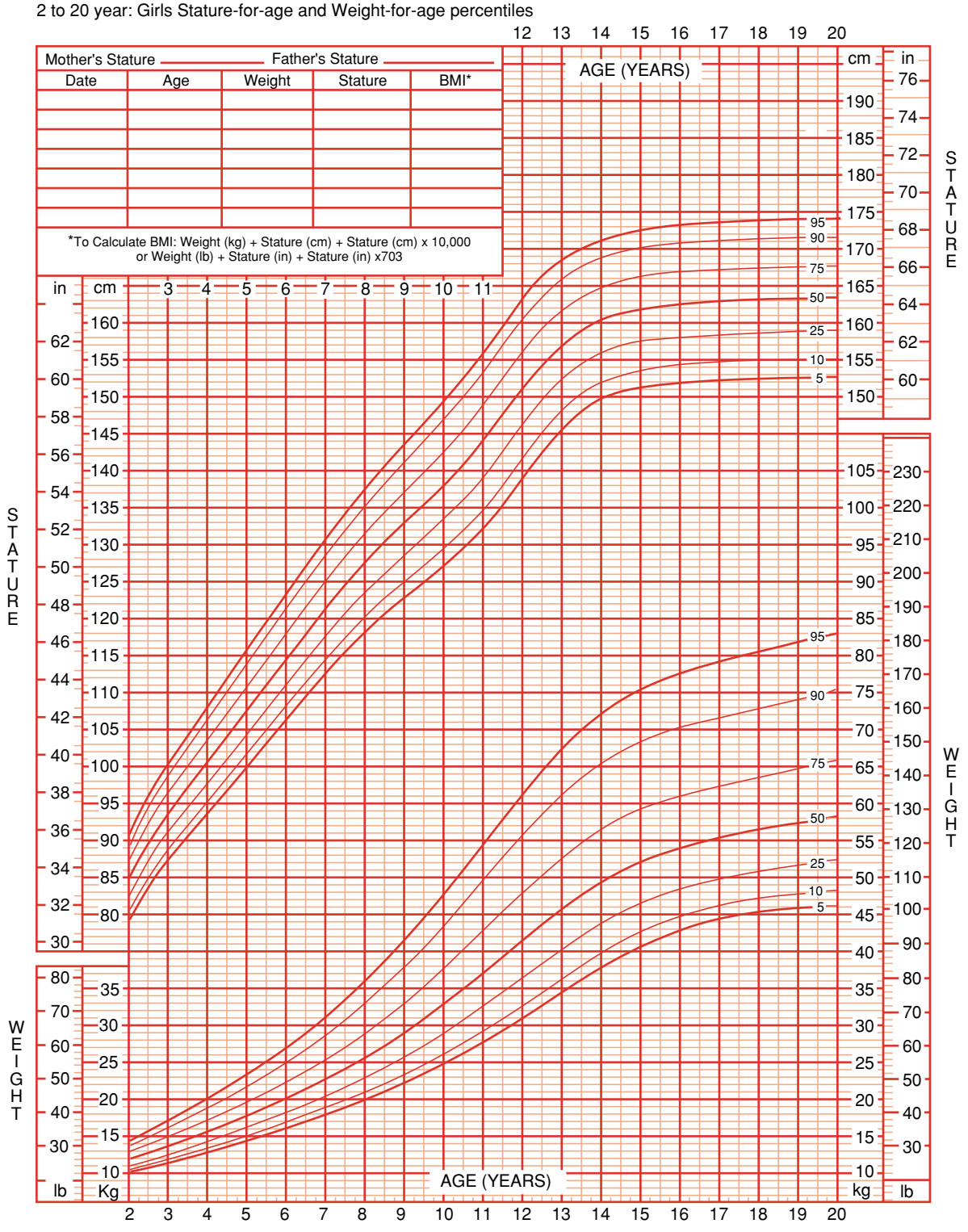

Figure 1D Source: Center for Disease Control, National Center for Health Statistics.

motor action in the extremities. The proximal-to-distal progression is seen in the coordination of upper extremities first, followed by lower extremities.

In general, the first year of life focuses on cephalocaudal and proximal–distal development. Growth and refinement of motor skills occur from ages 2 to 4 years. By year 1, the child is able to pull to a stand

Table 3 Newborn reflexes

Reflex	*Stimulation*	*Response*	*Age of disappearance*	*Function*
Rooting	Stroke cheek near corner of mouth	Head turns toward source of stimulation	3 weeks (becomes voluntary head-turning at this time)	Helps infant find the nipple
Sucking	Place finger in infant's mouth	Infant sucks finger rhythmically	Permanent	Permits feeding
Swimming	Place infant face-down in pool of water	Baby paddles and kicks in swimming motion	4–6 months	Helps infant survive if dropped into body of water
Eye blink	Shine bright light at eyes or clap hand near head	Infant quickly closes eyelids	Permanent	Protects infant from strong stimulation
Withdrawal	Prick sole of foot with pin	Foot withdraws, with flexion of knee and hip	Weakens after 10 days	Protects infant from unpleasant tactile stimulation
Babinski	Stroke sole of foot from toe toward heel	Toes fan out and curl as foot twists in	8–12 months	Unknown
Moro	Hold infant horizontally on back and let head drop slightly, or produce a sudden loud sound against surrface supporting infant	Infant makes an ''embracing'' motion by arching back, extending legs, throwing arms outward, and then bringing them in toward body	6 months	In human evolutionary past, may have helped infant cling to mother
Palmar grasp	Place finger in infant's hand and press against palm	Spontaneous grasp of adult's finger	3–4 months	Prepares infant for voluntary grasping
Tonic neck	While baby lies on back, turn head to one side	Infant assumes a ''fencing position''; one arm is extended in front of eyes on side to which head is turned, other arm is flexed	4 months	May prepare infant for voluntary reaching
Body righting	Rotate shoulder or hips	Rest of body turns in same direction	12 months	Supports postural control
Stepping	Hold infant under arms and permit bare feet to touch a flat surface	Infant lifts one foot after another in stepping response	2 months	Prepares infant for voluntary walking

and begin to take steps. Eventually, the toddler progresses from a wide-based gait to a well-coordinated, sequenced gait that can accomplish more complicated, sequential motor activities such as stair-climbing (by age 2) and skipping (by age 5). School-age children and, later, adolescents, continue to master more complicated sequential motor activities necessary for activities such as sports and driving, for example. Table 4 lists developmental milestones for the first 6 years of life only, given that this timeframe involves the most rapid change; beyond 6, change occurs across a less rapid trajectory.

Fine motor development The timing or acquisition of fine motor developmental milestones involves less variability than gross motor development. See Table 4 for further details.

Speech/Language Development

Table 4 provides an overview of language development from birth to age 6. Although infants do not often have formal word use until age 12 months, the first 12 months are critical to development in terms of understanding that words are concepts for objects. Ultimately, children will comprehend the meanings of various words as they continue to develop. It is not uncommon for a child to display slow mastery or use of new words until 18 months, followed by a burst of language production and comprehension at the end of the second year. Language skills continue to be acquired, including use of prepositions, adverbs, and adjectives (age 3) as well as rules of grammar (age 3–6 years). Language development from age 7 through adolescence focuses primarily upon the social pragmatics of the use of language.

Children display wider variability in speech and language development than any other area due to the variety of individual and environmental factors (e.g., the verbal environment of the child's home or child care facility). For example, children born to large families may exhibit delays in language production given the lowered frequency of attention and opportunities for verbal interaction when compared to single-child families. Bilingual children may also experience temporary (i.e., ameliorates by age 2–3 years) delays in language acquisition, often combining the two languages into a mutant language of their own. Furthermore, poverty can deleteriously affect infants' language development. Although being from a low-income home does not necessarily automatically yield language delay, it is a high-risk factor.

Cognitive Development

Piaget A plethora of theoretical perspectives regarding childhood development exists; the most famous of which is that of Swiss philosopher Jean Piaget. According to Piaget, children take an active role in working within their environment to incorporate experiences (which he referred to as the act of assimilation) into their personal schema (the way they interpret their world). As children learn and grow, they continually modify their schema when confronted with new events. Piaget labeled the child's modification of schema as accommodation. A child's ability to modify schema depends upon their current particular stage of development.

Piaget's stages include four levels. The first stage is the sensorimotor stage, which occurs between the ages of 0 and 2 years. During this stage, learning is facilitated by sensory means. For example, a baby within this age range prefers to hold and even explore a new object with his/her mouth in order to learn about it fully through sensory stimulation. By the end of the sensorimotor stage, children should master object permanence (i.e., understand that when the mother puts a block out of view behind her back, it is still present, just not visible) and symbolic (representational) thought. The latter may be seen in fantasy play, such as dress-up games.

The preoperational stage (ages 2–6) involves mental processes that are governed by the child's own subjective perceptions. Furthermore, the child does not make a distinction between internal and external reality. By the end of the preoperational stage, a child displays animism (e.g., believing the clouds and flowers smiled at her), egocentrism (i.e., understanding the world from his point of view, with less, if any, empathy for others), idiosyncratic and transductive reasoning (i.e., linking two usually unrelated events such as any woman wearing white and receiving a shot).

Once a child attains the concrete operational stage between ages 6 and 11 (or school age), s/he is able to classify and sort objects using stable concepts such as volume, mass, and number. It is during the concrete operational stage that children learn to conserve, or understand, for example, that a given volume of water remains the same when poured from a short, wide container as when poured from a tall, thin container. This is something that, Piaget proposed, children in the preoperational stage cannot do.

Lastly, there is the stage of formal operations, which covers the full range of adolescence. During this final Piagetian stage, the adolescent can successfully process abstract thought. Piaget suggested that not all human beings reach this level of cognitive functioning. It remains important for any forensic scientist to understand the various cognitive abilities related to each stage of child development. For example, in court questioning, one would not expect a child of 10 to be able to process abstract questions.

Table 4 Selected developmental milestones: birth to 6 years[a]

Age	*Gross motor*	*Fine motor: adaptive*	*Language*	*Personal–social: adaptive*
Birth	• Moves head laterally		• Vocalizes • Responds to bell	• Regards face
1–3 months	• Improves head control • Able to support head on neck by 3 months • Can bear weight on legs	• Visually follows 90°, 180°, and 360° consecutively • Clenches fists until 3 months • Brings hands together	• Quiets to noise • Coos (e.g., ''ooh,'' ''aah'') • Laughs • Swipes at objects	• Regards face and hand • Smiles responsively and spontaneously • Chuckles
4–6 months	• Can roll over • Can sit briefly without support • Can lift chest up using arm support	• Can grasp rattle • Grabs and shakes objects • Brings hands to midline	• Demonstrates different needs by producing different sounds • Blows ''raspberries'' (bubbles) • Turns toward sound (e.g., rattle) or voice • Has raking grasp • Can exchange objects (e.g., cube) from one hand to the other • Brings objects to mouth to feed • Regards objects (e.g., raisin)	• Regards own hand • Works for toy • Imitates speech sounds • Makes single-syllable consonant sounds • Can distinguish between ''pleasant'' and ''angry'' voices • Squeals
7–9 months	• Can sit without support • Can crawl on floor • Can stand while holding on to something	• Drinks from cup	• Mimics noises • Responds to spoken name • Understands ''no'' • Says ''mama'' or ''dada'' in nonspecific way • Indicates wants by pointing • Recognizes familiar words (e.g., ball, dog) • Combines syllables	• Can wave ''bye-bye'' • Puts many objects into mouth • Has object permanence (e.g., will look for lost objects) • Has separation anxiety
10–12 months	• Pulls to stand • Can stand for 2 s • Cruises holding on to furniture • First steps	• Uses pincer (i.e., thumb–finger) grasp • Mimics reading by turning pages • Scribbles	• Says ''mama'' or ''dada'' in specific way • Follows gesture command • Can say one specific word (by 12 months)	• Plays repetitive verbal games (e.g., pat-a-cake)
13–15 months	• Can stoop and recover • Climbs stairs using hands and knees • Can sit down from standing • Walks well, with wide-based gait	• Points with fingers • Has more fine motor control (e.g., stacks rings; puts block in cup) • Marks with pencil • Able to use spoon to feed self • Can open boxes	• Can say two specific words • Looks for named object (e.g., ''Where's the ball?'') • Responds to name • Obeys command: ''Give it to me'' • Names family members • Verbalizes jargon • Follows one-step commands without gesture • Has knowledge of one or two body parts	• Solves problems via trial-and-error • Has second bout of separation anxiety (first incidence occurs during 7–9-month period) • Can indicate wants (e.g., food preferences) • Can engage in independent play • Imitates household activities

16–18 months	• Can balance on one foot with support • Can walk backwards • Runs	• Enjoys playing with push–pull toys • Can take off/unzip clothing • Can build tower using two cubes	• Can point to simple pictures when asked • Can follow simple two-step commands • Can point to two pictures • Can say 3–5 specific words • Enjoys using the word ''no''	• May demand individual attention • Uses inventive solutions to problems • Less mouthing of objects except for food • Helps in house
19–21 months	• Can kick a ball forward • Can jump up • Can walk up steps with support	• Can put lid on box	• Can say 6–10 specific words • Enjoys being read to • Labels actions: ''up'' = pick me up • Questions: ''What's that?'' • Combines words • Uses echolalia	• May fear water • Can put on shoes • Washes hands • Imaginary play, e.g., ''tea party'' • Likes small objects • Uses spoon and fork • Uses pronoun ''I''
22–24 months	• Walks up and down steps alone, placing both feet on each step	• Can build tower using four cubes • Can match like objects • Draws horizontal lines • Can dress self	• Enjoys listening to stories • Repeats rhymes • Associates names with familiar objects • Has up to 50 words • Distinguishes ''one'' from ''many'' • Communicates feelings using words and gestures • Verbalizes toileting needs • Knows six body parts • Speech is 50% understandable	• Tests limits • ''Reads'' book to self • Can be easily frustrated • Does not understand concept of sharing • Engages in parallel play with peers
2–2$\frac{1}{2}$ years	• Throws ball in overhand fashion	• Has adult grip on crayon • Draws vertical lines • Can build tower using six cubes	• Uses two-word sentences • States name • Sings parts of songs	• Asserts independence • May say ''no'' often • Brushes teeth with help
2$\frac{1}{2}$–3 years	• Runs well • Alternates feet walking up stairs • Balances on each foot for 1 s	• Enjoys 6–12-piece puzzles • Can copy a circle shape • Can build tower using eight cubes	• Learns 50 words per month • Uses three- or five-word sentences • Can state full name • Understands concept of ''one'' • Can follow three-step directions	• Is able to play cooperatively • Can wash and dry hands • Can name friends
3–3$\frac{1}{2}$ years	• Balances on each foot for 2 s • Walks in straight line and backward • Catches and kicks large ball • Controls bowels and bladder during day	• Can copy a cross shape • Capable of stringing beads and other comparable activities • Knows colors and can match objects of similar hue	• Has approximately 900 words • Can repeat back three-digit numbers • Asks ''How? Why?'' • Understands prepositions • Knows and uses plurals, pronouns, some adjectives and adverbs • Speech is 75–100% understandable • Can talk about remote events	• Has improved attention • Can put on t-shirt
3$\frac{1}{2}$–4 years	• Hops	• Cuts with scissors • Puts shoes on correct feet	• Can count to 3 • Can make analogies	• Enjoys board/card games • Has memory for recent events

Continued

Table 4 Continued

Age	*Gross motor*	*Fine motor: adaptive*	*Language*	*Personal–social: adaptive*
4–5 years	• Somersaults • Learns ''heel-to-toe'' walking • Balances on each foot for 3–5 s	• Can copy some letters • Can copy a square when demonstrated • Can draw a person in three parts	• Understands and enjoys humor • Makes comparisons between objects • Speech understandable • Has one-to-one correspondence (e.g., counts five blocks) • Understands basic time concepts • Names categories	• May have imaginary friends • Loves to dress up in imaginative play (e.g., superhero, princess) • Aware of gender of self and others
5–6 years	• Capable of gross motor sequenced activity (e.g., skipping, swimming, biking) • Balance on each foot for 6 s • Can catch ball	• Distinguishes directionality (right from left) • Can draw a person in six parts • Can print full name • Can sort various objects by common size	• Speaks primary language fluently • Knows home address and birth date • Sings songs, shares stories • Understands quantity concepts • Understands sequences • Can define seven words • Begins to learn irregular plurals • Uses words to describe inner emotional state • Understands opposites	• Asserts independence • May fear death

Adapted from Batshaw ML (2001) *When Your Child Has A Disability: The Complete Sourcebook of Daily and Medical Care*. Baltimore: Paul H. Brookes; Psychological Corporation (1992) *The Preschool Language Scale III*. Harcourt, Brace, Jovanovich; *Denver Developmental Screening Tool II* (1992) Denver Developmental Materials.

[a]An average age of onset is given; children vary in acquisition of these milestones.

Emotional/Behavioral/Adaptive Development

Freud and psychoanalytic theory Although current developmental theorists view Sigmund Freud's psychoanalytic theory of development as too narrow in focus, most respect and recognize his importance as a pioneer in the field. Freud asserted that all children progressed through a series of five stages. Each stage involves crises to work through, the outcome of which ostensibly affects adult interpersonal and emotional functioning. The earliest phase (0–1½ years or infancy), or oral phase, revolves around feeding and oral gratification; in order to progress to the next stage, an infant "learns" to separate itself from its mother in learning the centrality of self (which Freud referred to as primary narcissism). The conflict of the second stage (anal; 1½–3 years) involves rebellion versus compliance with parental demands as well as fear of loss of parental love.

During the middle psychoanalytic stage (phallic; 3–6 years), the child's focus involves genital exploration. Successful transition from the phallic stage of development necessitates identification with like-sex parent after a period of rivalry stemming from sexual attraction to the opposite-sex parent (termed oedipal and Elektra complexes for boys and girls, respectively).

The challenge of defining oneself within the context of same-sex peers comes with the latency stage (ages 6–11 years). Genital exploration subsides and increased control of sexual and aggressive drives emerges. The child immerses him/herself in socially accepted activities during this fourth stage. Lastly, the genital stage of adolescence (beginning with puberty and continuing into adulthood) involves successful separation from parents as well as equally successful extrafamilial relationships (e.g., with peers).

Freud's pychoanalytic theory of development has fueled further theorization and research in the area, inspiring the subsequent theories of Neo-Freudians such as Ann Freud, Mahler, and Erikson. A forensic expert's knowledge of this theoretical perspective on childhood development can certainly assist in the understanding of a colleague or deposed expert who operates from a Freudian or psychoanalytic viewpoint.

Erikson Erik Erikson's theory of emotional development stems from Freudian theory, but with a broader, more advanced point of view. Each of the eight stages involves one central issue, which must be resolved in order for the individual to progress to the subsequent stage. Erikson's first five stages reflect the exact same age ranges as Freud's psychoanalytic stages. Each stage label is fairly self-explanatory in terms of the conflict that the child must overcome: (1) trust versus mistrust of the caregiver; (2) autonomy versus shame and doubt regarding the child's own independent caretaking capabilities; (3) initiative versus guilt in terms of accomplishment of early age-appropriate goals (e.g., toilet training); (4) industry versus inferiority, for example, in the area of early academic achievement; (5) identity versus role confusion for adolescents attempting to establish autonomy and sense of self; (6) intimacy versus isolation for social connection during young adulthood; (7) generativity versus stagnation in adulthood as career paths are established or sought; (8) lastly, old age involves ego integrity versus despair as the elderly individual reflects upon and evaluates his/her life accomplishments.

Abnormalities of Development

Clinicians stress the importance of periodic assessment of developmental milestones in order to chart each child's progress in skills acquisition across the four domains of development. Abnormalities of development are common in about 10% of children and can be global, in which a child shows delayed acquisition of skills across all four domains, or specific to one or more domains. Tjossem's three-category classification system for risk factors for developmental problems in children is commonly cited and includes established, biological, and environmental factors. An infant or child is placed at established risk by a medical disorder, including conditions resulting from genetic and chromosomal abnormalities. An infant or child is at biological risk due to prenatal, perinatal, neonatal, or early developmental insults. Examples include poor maternal nutrition, infectious diseases, or toxins passing through the placenta during pregnancy, and trauma sustained during delivery. An infant or child is placed at environmental risk by life experiences such as onset of a chronic medical condition, poverty, malnutrition, and child abuse and neglect.

Given the fact that each child's individual variability in development is related to a number of factors, any developmental assessment must include a thorough medical history (including birth, infections, hospitalizations, surgeries, medications), family history, physical examination for abnormalities and/or dysmorphic features that might suggest a genetic syndrome, and interviews with primary caretakers regarding the history of that child's acquisition of specific developmental skills (including emotional/behavioral/adaptive skills). In addition, developmental status should be documented.

Measurement of Development

Developmental status can be measured through two types of play-based tests: screening tests and

evaluation tests. A developmental screening test is a quick and broad assessment of skills; its purpose is to identify a subpopulation of children who are in need of further, more in-depth evaluation. Screening tests can either rely on a caregiver report of developmental milestones via a questionnaire or involve the standardized administration of items by a professional or paraprofessional. Developmental evaluation instruments are standardized measures that are administered by highly trained professionals such as a psychologist. These tests, more labor-intensive and prolonged (lasting 1–3 h), are used to create a profile of a child's strengths and weaknesses in a variety of developmental domains. The administrator then determines how these strengths and weaknesses will impact a child's interactions within multiple environments (family, school, and larger community). A discussion of specific screening and evaluation tools used to assess developmental progression is beyond the scope of this article; see references below for further reading regarding these types of tools.

See Also

Anthropology: Bone Pathology and Antemortem Trauma; Morphological Age Estimation; Pediatric and Juvenile; **Autopsy:** Pediatric; **Children:** Legal Protection and Rights of Children; Children and Courts; Physical Abuse; Sexual Abuse, Epidemiology; Non-inflicted Causes of Death; **Odontology:** Overview

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Legal Protection and Rights of Children

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Introduction

This article will attempt to discuss whether children, by which is meant persons under 18 years of age (as defined by Article 1 of the United Nations Convention on the Rights of the Child (CRC)), are mentally competent to comprehend the complex legal proceedings of an adult criminal court and competent to make decisional choices that will profoundly affect their future life.

We will explore brain development and attempt to connect this science to the law and procedures involving children, especially those charged with horrific crimes. We cannot address the many questions that exist as to these issues in one article but will attempt to give the reader the basis to go further into the subject.

The main questions that we address are:

- Should a "child" (Article 1 CRC) ever be subject to a criminal trial, especially where the sentence can be death or life imprisonment, with no possibility for release, without first being examined by medical, not legal, standards as to competency to understand the process, assist counsel, and have the ability to make decisions as to case outcomes?
- Has the juvenile court in the USA and procedures in other parts of the civilized world been so "criminalized" to have actually eliminated a true separate court and process for children?

We have looked at the original premise of the juvenile court and what today is presumed by many as "a scaled-down second-class criminal court for children" and conclude with questions on how, if possible, the science can be connected to the reality of present-day law.

There is no doubt that today children are involved in many violent and horrific crimes. This question remains: how does a civilized and humane society deal with these issues?

Discussion

Legal protection and rights of children are concerned with the theory that children are incapable of functioning mentally on an adult level because of immaturity. Current scientific research shows that the child's brain is vastly different from that of an adult. Research indicates that during childhood the brain continues to develop, contrary to what researchers believed in the past. While a child may physically appear to have developed into an adult, his/her brain has not fully developed into an adult brain. Because of this lack of development, the child may be mentally unable to make decisions on an adult level. This inability becomes particularly troublesome when the child enters the court system charged with committing a crime.

Throughout the USA and the world there is great concern about children committing horrific crimes at younger and younger ages, as exemplified by the recent cases involving Lionel Tate and Lee Boyd Malvo. In March 2001, the Florida court sentenced 14-year-old Lionel Tate to life in prison without parole for killing a six-year-old child. Tate's defense counsel argued that the child's death occurred as a result of Tate "demonstrating wrestling techniques" on her, but did not request a mental competency proceeding. Tate was 12 years old at the time. Lee Boyd Malvo, 18, confessed to the sniper shootings that occurred in Washington, DC, Virginia, and Maryland in 2002. He is currently being tried as an adult in Virginia. The state is seeking a death sentence. Malvo was 17 when the shootings occurred, in which 10 people died and three were wounded. Malvo is raising the insanity defense, in which he claims that his actions were the result of "indoctrination" and "transference" by John Muhammad, the 40-year-old adult involved in the shootings together with Mr. Malvo. Malvo confessed to the police officer after a lengthy interrogation. Psychiatrists have testified that because of the influence Muhammad had over Malvo, Malvo was unable to distinguish between right and wrong and committed the shootings to please Muhammad. This influence began when the child was much younger.

To deal with situations such as these, many jurisdictions in the USA have chosen to subject these children to adult court and adult sentences, including the death penalty. However, since many children may be unable to function mentally on an adult level, there are serious questions of whether the juvenile will be able to aid his/her attorney competently in the defense or even understand the court proceedings. There is no question as to the level of violence involved in the cases referred to and the public's right to expect accountability. The question is: what is accountability and are children, even those who commit horrific crimes, redeemable? Recent developments in child brain research may help to answer this concern.

In December 2003, Lee Boyd Malvo was convicted of the murder of Federal Bureau of Investigation analyst Linda Franklin. By convicting Malvo of capital murder, the jury rejected medical opinions and scientific findings on child brain development as to Malvo's competency to formulate intent and the idea that he was "programmed" by an adult. Psychiatrists had testified that because of Malvo's impressionability, youth, and unstable home environment, John Muhammad had been able to "brainwash" and "indoctrinate" Malvo into committing the sniper shootings. The fact that the jury was unable to accept these evaluations is evidence of the difficulty in transmitting to a fact finder the impressionability and mental development of children. However, his youth and immaturity played a major role in the penalty phase of Malvo's trial. On December 23, 2003, the jury sentenced Malvo to life in prison. This sentence does show some consideration for Malvo's immaturity because he was spared the death penalty. The jury used the medical evidence to mitigate but not excuse his actions with a "not guilty by reason of insanity" verdict.

Such actions taken by the jury raise the question of how do the medical and legal systems come to accept each other? In March 2004, the judge formally sentenced Malvo to life in prison without the possibility of parole. Sentencing a child to life without the possibility of parole violates Article 37 of the United Nations CRC, which prohibits the death penalty and any sentence that does not have a reasonable time for completion and release of the child. Article 1 of CRC defines a "child" as anyone under the age of 18. However, the sentence of life in prison did not appease the victims' groups connected with Malvo's case. In the USA, victims' rights groups have gained significant influence in criminal cases and often seek vengeance and not justice. Vengeance is an unconstitutional punishment. Malvo's sentence of life in prison without possibility of parole illustrates how vengeance may have influenced the judge and jury, regardless of the fact that he was a child.

Brain Development in the Child

The human brain weighs approximately 1.35 kg (3 lb) and is composed of different parts, called lobes.

The parietal and temporal lobes control the ability to learn languages and understand spatial relations. The frontal lobe makes up the largest portion of the brain. The prefrontal cortex, a small part of the frontal lobe located behind the forehead, controls abstract thinking, prioritization of thoughts, planning, the ability to anticipate possible consequences of actions, and the ability to control impulses. Up until now, scientists had believed that the human brain was fully developed in early childhood. However, Dr. Elizabeth Sowell, working in brain research at the University of California – Los Angeles (UCLA), discovered that the frontal lobe is the final part of the brain to develop completely and that it is the lobe that changes the most during childhood. Dr. Sowell and other UCLA researchers are working together with researchers at Harvard Medical School and the National Institute of Mental Health to map the development of the child's brain.

The researchers used magnetic resonance imaging (MRI) to scan the brains of children every two years from early childhood through adolescence and into the early 20s. Dr. Judith Rapoport of the National Institute of Mental Health conducted the first study in 1999. She and her colleagues studied brain development of 145 children and found that the brain undergoes a thickening process in a second overproduction of gray matter, the "thinking" part of the brain, just before the onset of puberty. This overproduction is mostly concentrated in the frontal lobe. Until that study, scientists only knew that the brain overproduced gray matter for a short time period from before birth through the first $1\frac{1}{2}$ years of life. Research shows that the brain's gray matter increases and decreases in different brain areas at different times of development. However, the overproduction of gray matter peaks at age 11 in females and age 12 in boys. Afterwards, gray matter is shed and discarded at the rate of 1–2% a year. However, the brain's white matter (wire-like nerve fibers connecting different parts of the brain) thickens progressively from birth and an insulating layer of myelin envelops the fibers. This insulation helps the brain focus and work more efficiently.

Researchers have discovered that a growth spurt of white matter starts at the front of the brain in early childhood, moves to the back of the brain, and stops after puberty. There are also growth spurts from age 6 to age 13 in the temporal and parietal lobes. However, researchers have found that production of gray matter occurs in the opposite direction from the back to the front of the brain, meaning that the frontal lobe does not fully develop until the early 20s. Researchers at UCLA have studied MRI scans of adults between the ages of 23 and 30 and of children ages 12–14. The study showed that the parietal and temporal lobes of the brain were fully developed in the child's brain. However, they found that adults have much more myelination in the frontal lobe than children. The research suggests that production of gray matter in the frontal lobe relates to the maturation of cognitive processing but the sensory, auditory, and language centers of the brain are fully developed in the child's brain.

In a correlating study led by Dr. Deborah Yurgelun-Todd of Harvard Medical School, researchers studied functional MRI scans of children viewing various pictures of faces showing different expressions. The study revealed that children in their early teen years used the amygdala center of the brain that mediates fear and "gut" reactions. Males tended to use the amygdala center more than females because the male frontal lobe develops slower in males. As the children age, they begin to use the frontal lobe in identifying the expressions. This suggests that as the children age they use reason more than "gut" instinct.

Dr. Ruben C. Gur has argued that current research strongly suggests that the human brain does not fully mature until the early 20s. The last areas to mature are the regions of the brain that control impulsivity, judgment, planning, and foresight of consequences. Dr. Gur suggests that the age of 21 or 22 is closer to the "biological" age of maturity.

Legal Consequences of the Research

If the brain does not mature until the age of 21 or 22, there may be significant legal consequences involved in the processing of juvenile offenders. The above research suggests that children are not emotionally or cognitively mature enough to understand the ramifications of their actions or the legal process. The juvenile justice system is based on the common-law presumption that children are mentally mature by the age of 14 and thus have all the reasoning abilities of an adult to formulate intent. The American court system currently operates under this idea and allows states to impose the death penalty for offenders who commit capital crimes as young as 16 years of age. However, it must be noted that, because of the lengthy appeals process in the USA, it is not uncommon for offenders to spend between 10 and 20 years or more on death row awaiting execution. At the time of execution, the offender is no longer a child. But the new research findings suggesting the brain does not fully develop until the early 20s brings to light issues of whether the teenage offender is mentally culpable for actions taken during childhood. The issue is not when the person is executed, but when the sentence was imposed.

The US practice of executing offenders who commit capital crimes during childhood has drawn criticism from the European Union, the United Nations, and the Inter-American Commission on Human Rights (IACHR), a branch of the Organization of American States. In October 2002, the IACHR ruled that the USA violated the norm of *jus cogens* (internationally recognized standards of decency) when it allowed the imposition of the death sentence for Michael Domingues. Domingues, a Mexican national, broke into a woman's home in Nevada at the age of 16 and murdered her and her four-year-old son. He was sentenced to death at the age of 17 for the two murders and currently awaits execution. Even though he was ruled competent to formulate the necessary intent to commit the crimes, there are questions of whether he was competent to comprehend the judicial process that led to his death sentence.

On October 31, 2003, the IACHR issued a report to the US government regarding the case of Napoleon Beazley. The state of Texas executed Beazley on May 28, 2002 for the April, 19, 1994 murder of John Luttig while burglarizing Luttig's vehicle in the driveway of his home. Beazley was 17 years old at the time of the murder. The IACHR found that the USA violated the international norm of *jus cogens* and also violated Beazley's right to life under Article I of the Commission's Declaration of the Rights and Duties of Man. The IACHR recommends that the USA review its laws that allow execution of individuals who were under 18 years of age at the time of their capital offense. It is cases such as these that call into question the developmental immaturity of juvenile offenders and the concept of legal competency.

Legal Competency of the Child

While there is no precise legal definition of competency, the issue of competency has mostly been used in the legal processing of adult offenders who are mentally ill or retarded. However, as scientific research shows, juveniles are developmentally immature and thus, seemingly, are less competent to make decisions effectively on an adult level. These observations are reinforced by the results of the MacArthur Foundation Juvenile Competency Study.

The MacArthur study tested individuals between the ages of 11 and 24 to compare the capacities of children and adults as trial defendants. The test analyzed their responses to a series of questions about hypothetical situations and the decisions available in each. The reasons for the responses were evaluated to determine psychosocial maturity, including the "ability to evaluate risk, to think about future consequences, and to resist peer pressure." Extrapolating the test results to the US population as a whole suggested that approximately one-third of 11–13-year-olds and one-fifth of 14–15-year-olds are probably not competent to stand trial. Many of the children in the study did not understand the judicial process, including the role of the jury and judge. Also, they were less likely to understand their legal rights even with an explanation of what the rights contain. These findings were consistent even for the children who had prior contact with the legal system. Other studies indicate that when juveniles are questioned by authority figures they are more likely to answer in a manner they believe the questioner wants. It is arguable that this may have been what happened in the Lee Boyd Malvo murder case. When questioned by the authorities, Malvo admitted the shootings and even that he enjoyed committing them. Because of Malvo's impressionability and immaturity, he may have been trying to please the adult authority figures in order to be released, as many children do with parents, school officials, or when involved in the justice system. These findings are significant in that even though juvenile offenders have the right to remain silent and to have an attorney, most states allow the juvenile to decide whether or not to waive these rights without a prior finding of competency.

The practice of allowing juveniles to waive these important rights assumes that juveniles are competent to make these decisions knowingly and intelligently. This assumption is contrary to the research findings outlined above. While the juvenile offender may waive these rights, a judge, but most often the prosecutor in the USA, will make the decision of whether the juvenile offender will be tried in juvenile court or waived over to adult court. In *Kent* v. *United States*, 383 US 541 (1966), the US Supreme Court outlined a list of factors judges must consider in making this decision. Among these are:

- the seriousness of the alleged offense
- whether community protection requires the waiver
- whether the offense was committed in an aggressive, violent, premeditated or willful manner
- the sophistication and maturity of the juvenile as determined by his/her home environment, emotional attitude, and pattern of living.

However, this analysis may be moot when the state gives the prosecutor the right to transfer the juvenile offender to adult court, on the basis of the offense charged as opposed to the maturity and competency of the child, or the state lowers the age of automatic transfer to age 16 or, in Florida and New York, even 14, and for murder cases presumably any age. This fact raises the question of whether or not prosecutors should have to follow the same standards as judges,

outlined in Kent. It seems that it would be a mistake not to make the decision to transfer a juvenile offender to adult court based on competency and the Kent standards.

Juvenile courts were developed on the basis that children do not have the same decision-making capabilities of adults and are therefore less culpable for their actions. As the Court pointed out in Kent, "the juvenile court is engaged in determining the needs of the child and of society rather than adjudicating criminal conduct. The objectives are to provide measures of guidance and rehabilitation for the child and protection for society, not to fix criminal responsibility, guilt, and punishment." This finding may be questionable under present laws and procedures. Special safeguards were built into the juvenile justice system but should contain no less due process than for adults, especially as to competency and assistance of competent legal counsel. If the juvenile courts do not recognize this as a legitimate role for a separate court for children, then the question of whether there is still a need for a separate judicial venue for children arises. The eminent legal scholar Professor Barry Feld argues that there may no longer be a need for a separate juvenile court because in adult courts the defendant would receive full due process protections, including competency exams. Feld concludes that the juvenile court of today has been "criminalized" without including the full due process of an adult court.

The two elements of legal competence are: (1) competence to assist counsel; and (2) decisional competence.

The US Supreme Court stated a two-part test of whether a juvenile offender can competently assist counsel in *Dusky* v. *United States*, 362 US 402 (1960). The test is whether the youth has "sufficient present ability to consult with his lawyer with a reasonable degree of rational understanding" and "whether he has a rational and factual understanding of the proceedings against him." Dr. Thomas Grisso and other justice researchers have recognized that a juvenile may be able to assist counsel but be incompetent to make decisions about his/her defense. The Lionel Tate case is illustrative of this point.

In Tate's case, the state of Florida offered Tate a three-year sentence in a juvenile facility as opposed to the sentence he ultimately received, which was life without any chance for parole in prison, i.e., until death! Tate rejected this offer. It is questionable whether such a decision can be conceived of as understanding the legal process. Decisional competence involves understanding, appreciation, reasoning, and choice. These abilities are governed by the frontal lobe, which research now shows does not fully develop until the early 20s. The holding of the Florida Fourth District Court of Appeal of Florida overturning Tate's sentence reinforces these findings. The court concluded that Tate's due process rights were violated when the lower court did not *sua sponte* order a competency evaluation of Tate to see if he was mentally capable of aiding in his own defense. The court stated that, because of Tate's extremely young age and lack of prior exposure to the judicial system, a "competency evaluation was constitutionally mandated to determine whether he had sufficient ability to consult with his lawyer with a reasonable degree of rational understanding and whether he had a rational, as well as factual, understanding of the proceedings against him."

The court recognized that Tate is entitled to a new trial because a competency hearing done three years after he was sentenced "to determine the present competency of a maturing child cannot adequately retroactively protect his rights."

However, it must be emphasized that the court did not solve the problem of whether any juvenile is really competent to aid in his/her own defense. The court limited its holding to the Tate case and stated that "competency hearings are not mandated simply because a child is tried as an adult." Furthermore, the court recognized that the trial court should have inquired whether Tate may be "competent" and not whether he is "incompetent." But the Tate court also emphasized that in Florida children do not have an absolute right to be treated in a "special system for juvenile offenders." Florida and other state legislatures have chosen to use a statutory system that specifies at what age a child may be tried as an adult instead of utilizing the common-law "infancy" defense. Because these statutory systems leave the decision whether to try the child as an adult to the state prosecutor, perhaps those prosecutors should be under the same standards applicable to judges under Kent.

Since current research indicates that the human brain is not fully developed until the early 20s, juvenile offenders may not have the mental capacity to waive any of their rights. This issue raises the question of whether the child and society would be better served if these rights could not be waived. To safeguard these rights, it would seem the law should require a Kent-like proceeding to determine competency in the juvenile court with counsel present at every stage of the proceedings. Such safeguards should be especially required in cases where the child is being tried as an adult and the death penalty or life without parole is a possible sentence. With the new indications about brain development in adolescents, justice researchers could argue that it is neither

legally right nor morally right to try juvenile offenders as adults, especially when the sentence could be death or life imprisonment. International standards of juvenile justice might better protect the legal rights of children under those circumstances. It should be noted that Article 37 of the CRC prohibits the incarceration of any child for life without possibility of release and also prohibits a death sentence for a child.

Conclusion

The issues surrounding the legal protection of children are greatly determined on how children are treated once they enter the legal process. Juvenile courts were established to rehabilitate juvenile offenders based on the theory that children differ mentally from adults. Recent scientific research lends credit to this theory by showing that the human brain is a "work in process" until the early 20s. Since the frontal lobe is the last part of the brain to develop and given that it controls reasoning ability, childhood immaturity is arguably a component of incompetency to stand trial. It is questionable whether an alleged juvenile offender really has the mental capacity to understand the charges against him/her and the possible outcomes to be able to assist a lawyer in the child's defense. Because the USA allows imposition of the death penalty for crimes committed as a juvenile, the American justice system attempts to turn juvenile offenders into adults because of the crimes they commit. The juvenile court was created to prevent this happening. Perhaps it is time to consider returning to the common-law presumptions as to a child's ability to formulate intent and as a last resort, accept the findings and recommendations of Professor Feld and totally abolish the separate judicial process for children. We must also ask, when will the legal system connect the reality of process to the science of childhood brain development?

See Also

Children: Stages of Development and Growth; Children and Courts

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Children and Courts

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Introduction and Scope

During the last half of the twentieth century, court cases involving children as victims of various types of crime became a common fixture of courtrooms in the USA, the UK, and many other parts of the world. In addition, judges in many countries have concentrated more attention on protecting children from various forms of abuse, neglect, and abandonment caused by their primary caretakers. The phrase "child abuse" or "child maltreatment" was rarely used in the USA until the seminal works of Dr. John Caffey and Dr. C. Henry Kempe made the phenomenon emerge and remain in the public conscience (**Figure 1**).

The huge increase in numbers of reported cases of child maltreatment has resulted in a new courtroom focus on the forensic abilities of various experts from

Figure 1 Dr C Henry Kempe. Reproduced with permission of J Lauridson, © 2004.

a variety of fields. Expert medical witnesses have become a vital and indispensable part of courtroom proof in cases involving children and this has resulted in an unprecedented interaction between medical professionals and lawyers. Those whose task is to prove, or disprove, allegations of child physical abuse, child neglect, or homicide have turned to medical science to answer a number of perplexing questions. Medical forensic experts are regularly asked to assist in identifying the cause and possible mechanism of a child's injuries, determine the likely time when such injuries were caused, and sort between accidentally caused and intentionally inflicted lesions. In all countries where child maltreatment has become a regular fixture in the legal process, those who attempt to prove that caretakers purposely inflict injuries on children in their care have faced the difficult task of overcoming general disbelief among the populace. The vast majority of the public does not mistreat the children in their charge. The concept itself is so foreign that when such people sit in judgment of others charged with such an offense, they often struggle with finding another guilty of such conduct. When this is coupled with the facts that most child victims are either too young or too injured to assist in identifying the cause and mechanism of their injuries, and that proof in the courtroom is often made up exclusively of circumstantial evidence, judges and juries often look to forensic medical experts to provide the ultimate answers.

An equally important revolution has occurred in the field of child sexual abuse, where the forensic challenges may be even more difficult. Medical experts are asked to make fine distinctions between genital injuries that could have been self-inflicted by the child or accidentally caused and those that are consistent only with sexual conduct by some other person. This article will focus primarily on physical injuries and homicide of children related to abuse or neglect.

This article will also focus on the role of the medical forensic expert as a vital contributor to the modern child maltreatment courtroom process. A subsidiary focus will be on the expert's ability to perform the dual role in educating the trier of fact as to sometimes complex medical concepts and then expressing opinions based on the state of forensic knowledge as to the key issues in a child maltreatment trial. Examples will be offered showing how forensic experts can use visual illustrations, computer-generated diagrams and animations, and other media to simplify and enhance this vital role.

Identification of Cause, Manner, and Timing of Physical Injuries to Children

Identifying the Cause

Since there are rarely any eyewitnesses to acts of abuse causing injury to children, unless those eyewitnesses are too young to testify or are in league with the abuser, courtroom proof of the cause of injuries depends upon the expertise of forensic pathologists and/or clinicians. In most cases, whether the child died from the abuse or not, both types of expertise may be helpful, since clinicians regularly see and diagnose the cause of a wide variety of usually nonfatal injuries, while the pathologist must regularly interpret the cause and manner of fatal injuries to children. The range of injuries found in victims of child abuse run the gamut from subtle marks that are quite difficult to interpret to severe closed-head injuries caused by violent forces to marks that were clearly caused by impact with some object where the only issue is what object and who wielded it? Forensically trained experts use the collective knowledge gained by those in their respective fields to answer such questions. Most such questions are ultimately resolved, though, by common sense.

Given the general public disbelief concerning child abuse, getting a judge or jury to accept that someone intentionally or knowingly harmed a child is often very difficult. Experts must give the trier of fact a basic education about the medical issues in the case, and attorneys must then trust that the persons sitting

in judgment are capable of applying that education to the facts of the case. As with most types of learning in the twenty-first century, those issues reinforced with graphic support make the most impact. The modern forensic expert must master not only his/her science, but the art of persuasion and teaching, as well.

One of the first tasks in identifying the cause and manner of an injury or set of injuries is to examine the history provided by the person providing care for the child when the injury likely occurred. Although defalcation about the cause of injury is likely in cases of inflicted trauma, the perpetrators rarely lie about the onset of symptoms. The most important information for a forensic expert asked to express an opinion as to when an injury occurred is often examination of the behavior of the child over the last several days before the significant injury or death. Indeed, some experts have said that the cardinal sign of child abuse or inflicted injury is discrepant or evolving history to explain an injury. Where the story just doesn't fit the severity and nature of the injuries to the child, or where the caretaker should know what happened, but claims that nothing occurred, inflicted trauma should be suspected.

Modern technology has greatly simplified the sometimes painstaking process of matching injuries to their cause. A simple example of this is offered in Figures 2–4.

Forensic experts are often asked to match an injury of unclear etiology with its cause. In this case, a search of the crime scene yielded the object responsible for the injury. Often, a well-trained forensic pathologist or physician can deduce that several different injuries are in fact related in cause. In the case illustrated in Figures 5–7, the child victim was identified at autopsy to have a small amount of blood at the tail of the pancreas, but no other apparent abdominal bleeding; a small amount of subdural blood in the spinal cord; and unusual marks and bruises apparently overlying this area on her back near the spine. Although it was possible the injuries were unrelated to each other in mechanism and even timing, the possibility was raised during investigation that they were in fact related. Through this series of still graphics, the expert pathologist illustrated a cause that would explain all three injuries having been caused by a severe blow to the back of the child (Figure 7). This same child had several paired sets of punctate marks in various locations on her body. The pathologist conducting the autopsy requested the police investigators to search the victim's environment for an object that might account for these marks. The police discovered a corncob skewer in the child's toy box, which, when matched to the scale of the injuries through overlays, perfectly matched the puncture marks on her body. Given the fact that some of these marks were in the middle of her back, the expert pathologist was later

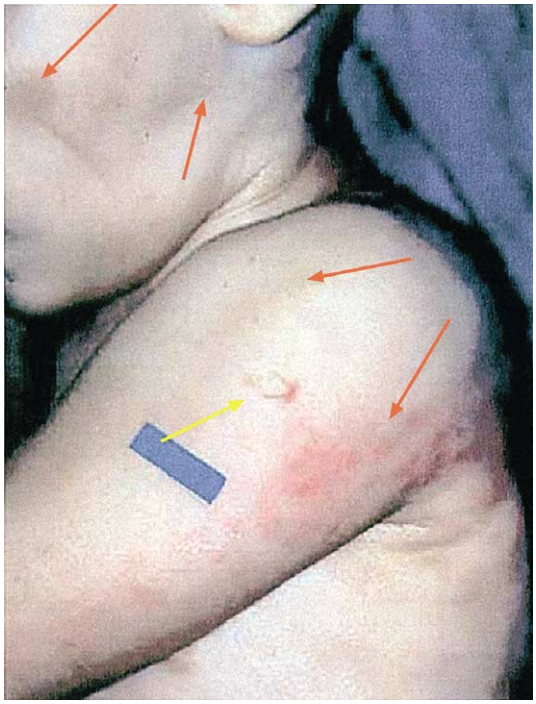

Figure 2 Unclear patterned-mark on a child. Reproduced with permission of J Downs, © 2004.

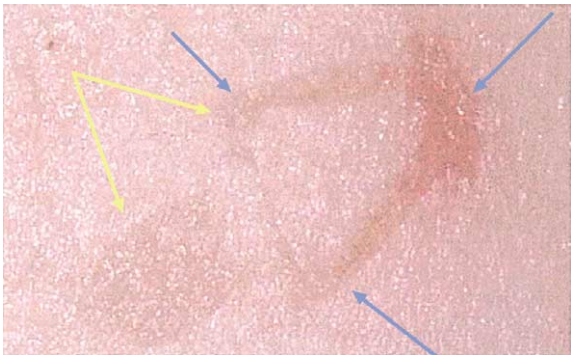

Figure 3 Scaled pattern of object suspected to have caused injury. Reproduced with permission of J Downs, © 2004.

Figure 4 Actual overlay of the object (lighter) and the injury. Reproduced with permission of J Downs, © 2004.

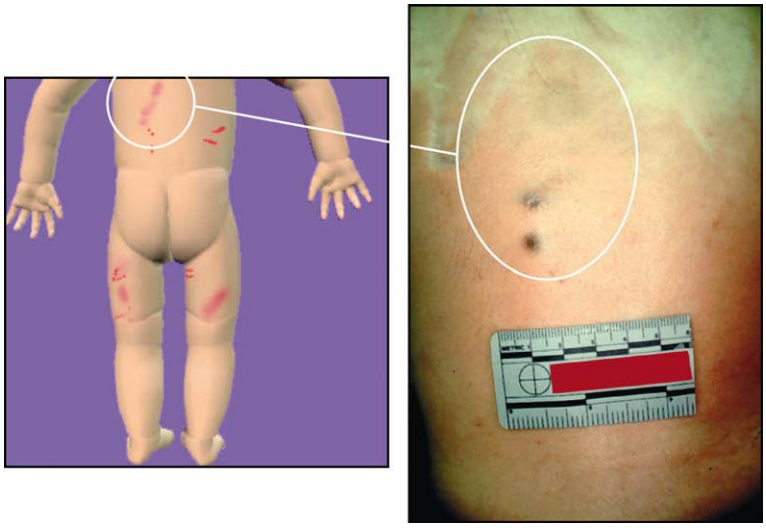

Figure 5 External bruises/marks on back. Reproduced with permission of J Lauridson, © 2004.

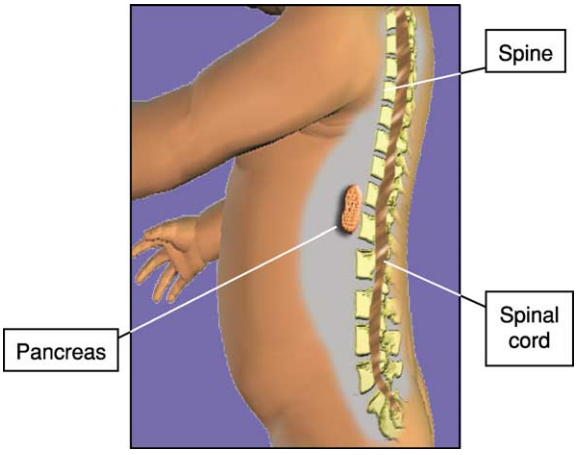

Figure 6 Blood at tail of pancreas and in spinal cord. Reproduced with permission of J Lauridson, © 2004.

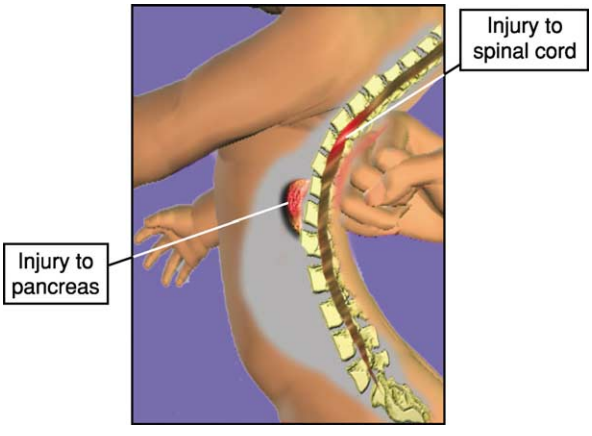

Figure 7 Mechanism accounting for all three injuries being contemporaneous. Reproduced with permission of J Lauridson, © 2004.

Figure 8 Punctate marks on the child's chest. Reproduced with permission of J Lauridson, © 2004.

able also to opine that these were inflicted by some other person, not self-inflicted (Figures 8–11).

One of the most difficult aspects of forensic medical work in child abuse cases is determining which injuries might have been caused by accident and contrasting those which are consistent only with inflicted trauma. The task is made somewhat simpler when all the injuries of similar age are considered together as a pattern, since when some injuries were quite obviously inflicted, it makes it more likely that all were part of the same assault on the child. Thus, although certain bruises might, if they happened in isolation, have been caused by accident, when they

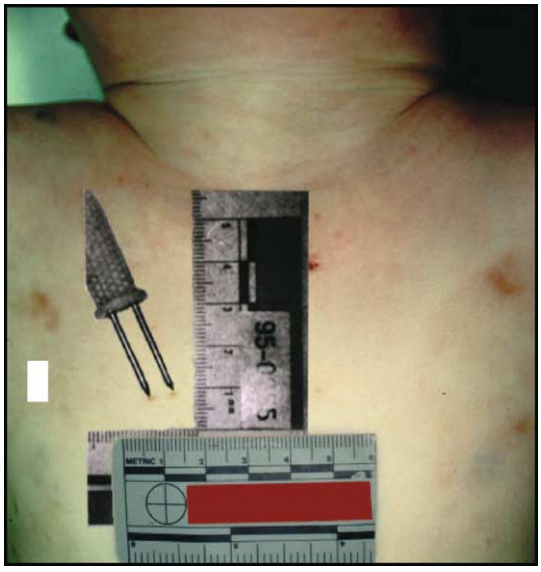

Figure 9 Matching overlay showing corncob skewer. Reproduced with permission of J Lauridson, © 2004.

are considered together with other inflicted injuries the cause becomes clear.

In the case illustrated in Figures 12–16, a 9-month-old infant was allegedly found on her back having supposedly smothered under a stack of blankets. The lividity pattern shown in Figure 12 allowed the expert pathologist to opine that the baby had been in a face-down position for at least a significant period of time after her death, which had likely occurred hours before she was discovered, contradicting the caretakers' version of events. The remaining figures illustrate other injuries documented at the time of autopsy, which included a blunt-force tear of the ear (Figure 13); multiple facial bruises in various stages of healing (Figure 14); a grab mark on the child's forearm (Figure 15); and healing damage to the gums at the position of the frenulum (Figure 16). Although the caretakers offered accidental explanations for each of these injuries, their stories were inconsistent with the mechanism, timing, and severity of the injuries. For instance, the child's

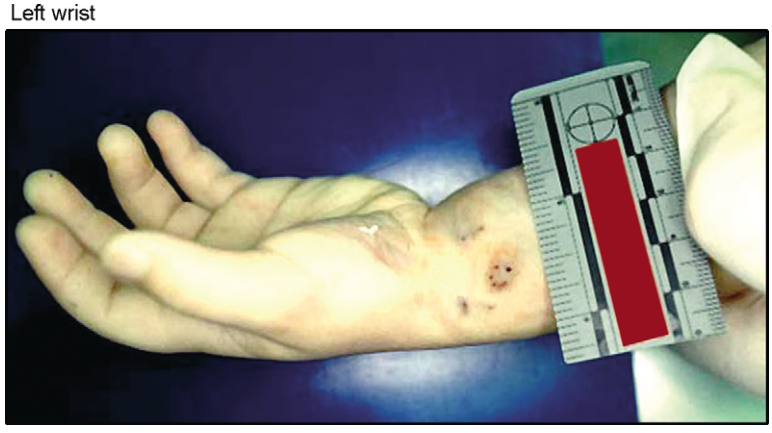

Figure 10 Punctate marks on wrist. Reproduced with permission of J Lauridson, © 2004.

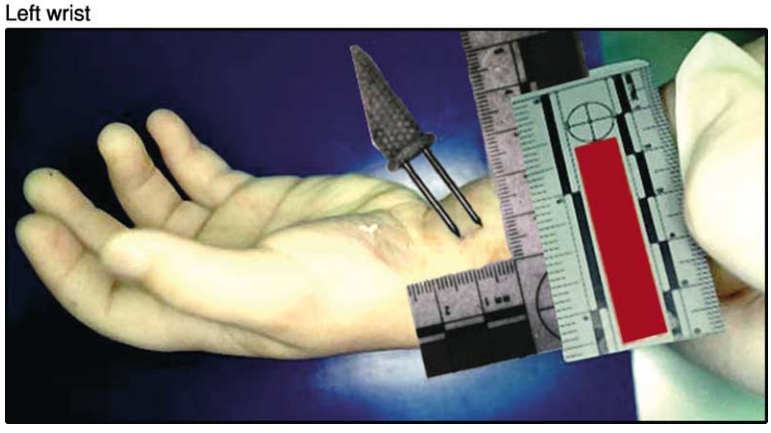

Figure 11 Overlay showing corncob skewer match. Reproduced with permission of J Lauridson, © 2004.

Figure 12 Lividity. Reproduced with permission of J Lauridson, © 2004.

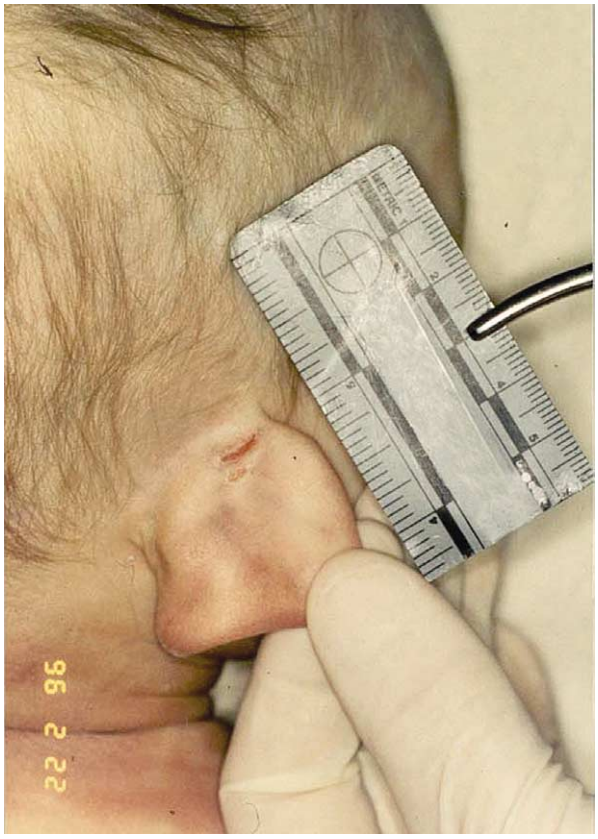

Figure 13 Tear behind ear. Reproduced with permission of J Lauridson, © 2004.

mother claimed that the gum injuries were caused by the paramedics who performed life-saving measures on the child. The forensic expert pathologist was able to refute this claim by pointing out that when the paramedics arrived the child had been dead for at least a couple of hours and since the gum injuries show evidence of inflammation and inflammation cannot occur postmortem, the paramedics could not have caused the injuries. In addition, the medical experts refuted the mother's claims that the child's facial bruises, leg and arm fractures, and other injuries were caused when the baby was trapped in the crib. Ultimately, a jury rejected all of the mother's and her boyfriend's accidental explanations for the injuries and convicted the mother of murder and the boyfriend of child physical abuse.

Verbal descriptions by forensic medical expert witnesses of such things as internal abdominal injuries are simply insufficient to convey the force that would be necessary to cause such an injury. In Figures 17–19, a simple computer animation was used to illustrate the position of the injured internal organs, the nature of the force that would have been required to cause the injury, and the resulting leakage of intestinal contents into the abdominal cavity, ultimately causing peritonitis and the child's death. Similarly, the pattern of a burn injury alone can allow an experienced forensic expert witness to explain and illustrate in court the difference between an inflicted burn and one caused by accident. In most cases of inflicted burn injuries to children, the caretaker attempts to account for the injury by claiming the child turned the water on him/herself, or climbed into a bathtub which already had extremely hot water in it. The expert can explain that, in either scenario, the child's burns would have appeared to be irregular, splash-type patterns, since the child would have struggled to get out of the burning water. By contrast, when the burns are distinguished by clear and even lines of demarcation between burned and spared skin, and especially when certain parts of the skin are spared from burning, it becomes clear that someone must have held the child in the burning water to create the pattern of injury (Figures 20–23).

In many jurisdictions, there are limitations placed by courts upon what types of demonstrative evidence may be introduced, and most restrictions apply in jury trials. Photographs of the victim's injuries taken during the autopsy process are often considered gruesome and unfairly prejudicial to the accused. Some courts make a distinction between preevisceration and postevisceration autopsy photographs, holding that the latter are always presumed to be too gruesome to be admissible as evidence unless there is

a particularized and unique need to introduce such photographs. Attorneys whose task is to illustrate and prove the cause of internal injuries face the further problem that internal autopsy photographs are very difficult for the untrained to interpret, and may be so distasteful that jury members cannot look at them and thus risk missing the point. Computer diagrams and animations can greatly enhance the expert's ability to explain and illustrate in a manner understandable to everyone the nature, location, and cause of internal injuries to a child. Such diagrams and animations, if based upon the original findings at the autopsy, may be the preferable method for illustrating forensic expert testimony.

Figure 14 Facial bruises and lacerations. Reproduced with permission of J Lauridson, © 2004.

Possibly the most difficult medical and anatomical concepts to teach to those who have no prior training, such as judges and juries, are those associated with closed-head injuries in children. Concepts such as axonal injury, subdural hematoma, retinal hemorrhages, and retinoschisis are virtually impossible to convey successfully by words alone. Modern computer technology has allowed easier methods not only to teach basic anatomy of each of these concepts, but also to illustrate the mechanism that results in various forms of trauma to the brain and eyes during severe rotational trauma inflicted upon the child's head. Figures 24–30 represent still images which are part of computer animations illustrating the mechanism of injury of such conditions as subdural hematoma and retinal hemorrhages.

Identifying the Timing of Injury

For virtually any injury or set of injuries inflicted upon a child, there are fairly well-recognized symptoms that would appear a particular amount of time following infliction of the injury, assuming the child is otherwise neurologically normal. With severe head injuries, there is a consensus among qualified experts that the

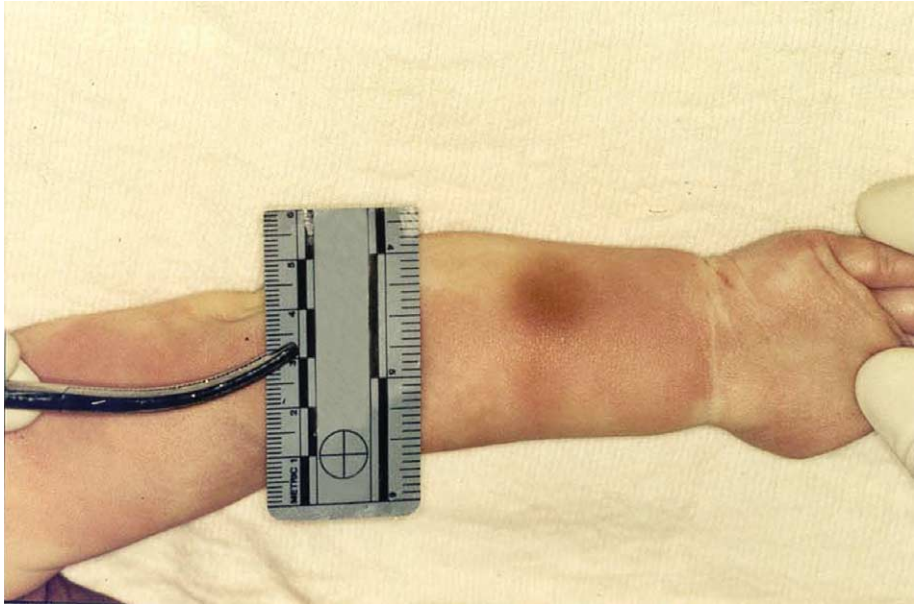

Figure 15 Grab mark on forearm, overlying radius fracture. Reproduced with permission of J Lauridson, © 2004.

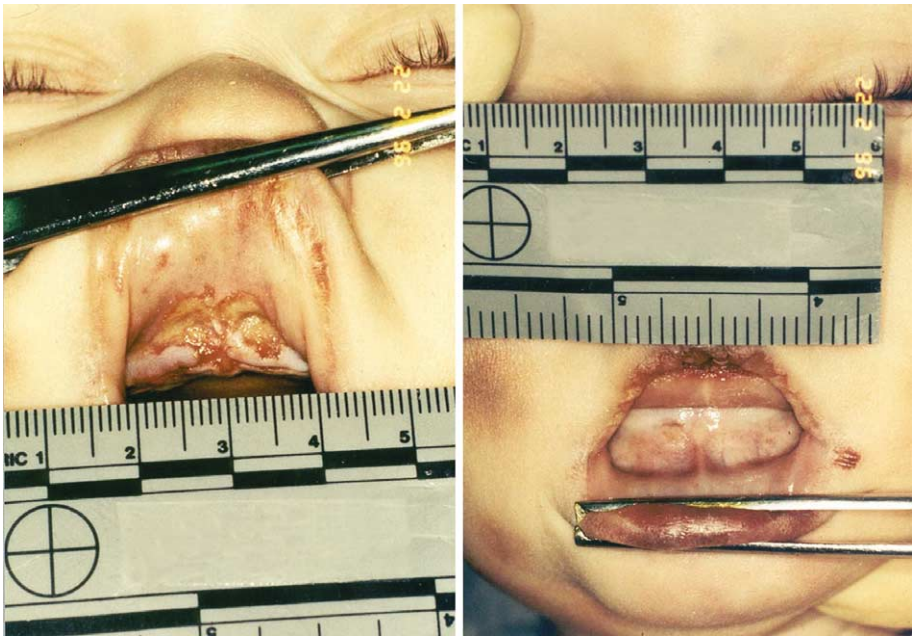

Figure 16 Healing damage to gums, not caused by postmortem. Reproduced with permission of J Lauridson, © 2004.

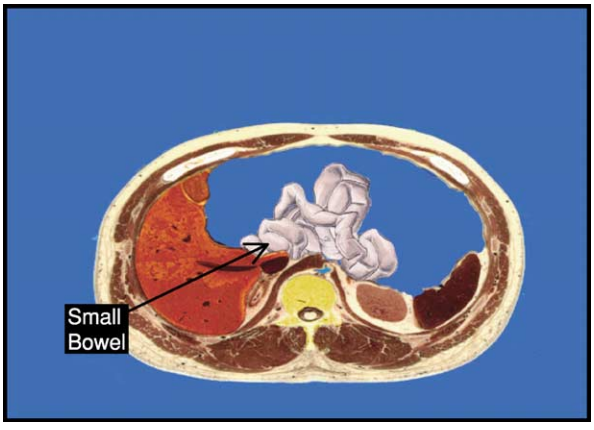

Figure 17 Anatomy of abdominal cavity. Reproduced with permission of J Lauridson, © 2004.

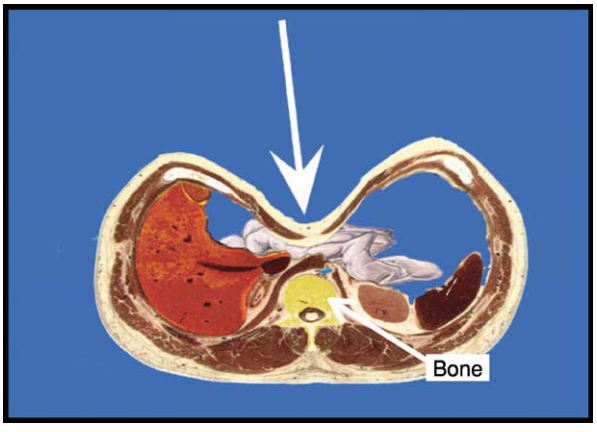

Figure 18 Nature and direction of blow. Reproduced with permission of J Lauridson, © 2004.

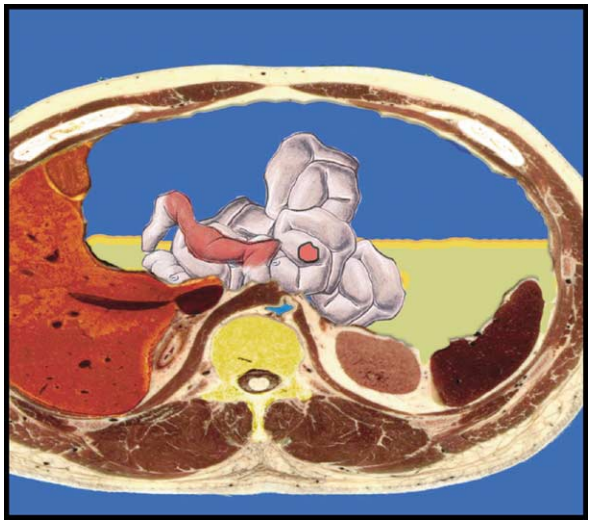

Figure 19 Peritonitis resulting from tear of the lower bowel. Reproduced with permission of J Lauridson, © 2004.

onset of symptoms would be immediate and even laypersons observing the child would recognize that the child is not "normal," but has suffered a serious injury. With bruises, internal injuries, and other forms of injury the symptoms may take some time to appear, but should be noticeable. For instance, when a child suffers a blow or compressive trauma sufficient to cause a bruise, it causes pain which should be obvious if a person is present. Fractures of the bone are painful not only when first caused, but remain persistently painful when the part of the body is manipulated in certain ways, often for several days.

Figure 20 Diagram showing mechanism of immersion burn to infant. Reproduced with permission of J Lauridson, © 2004.

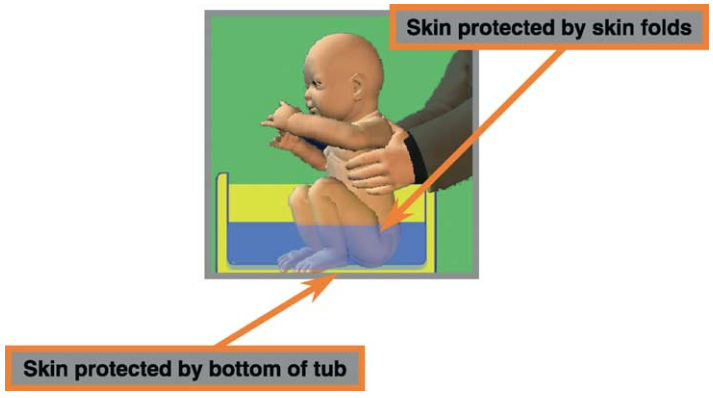

Figure 21 Diagram showing burned and spared areas of skin. Reproduced with permission of J Lauridson, © 2004.

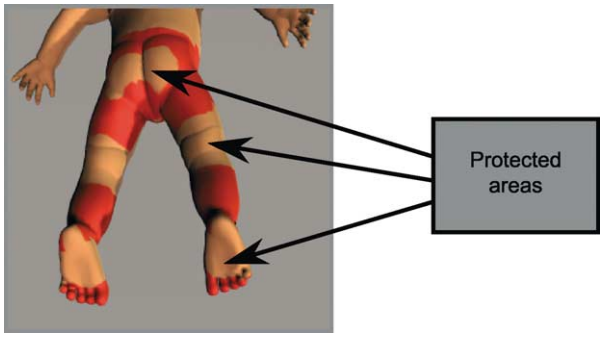

Figure 22 Actual injuries suffered by child. Reproduced with permission of J Lauridson, © 2004.

The medical forensic expert, if limited to only medical information gleaned from the nature of the injuries, can only express qualified opinions about when an injury was caused. Such an expert must be provided with information concerning what others have said about the child's behavior surrounding the apparent time when the child was injured. It is the application of known medical science to the facts in each case concerning when the child changed from apparently well to injured or symptomatic which allows the qualified expert to express a helpful opinion concerning timing of injuries in court. Developing

Figure 23 Several views of the burns. Reproduced with permission of J Lauridson, © 2004.

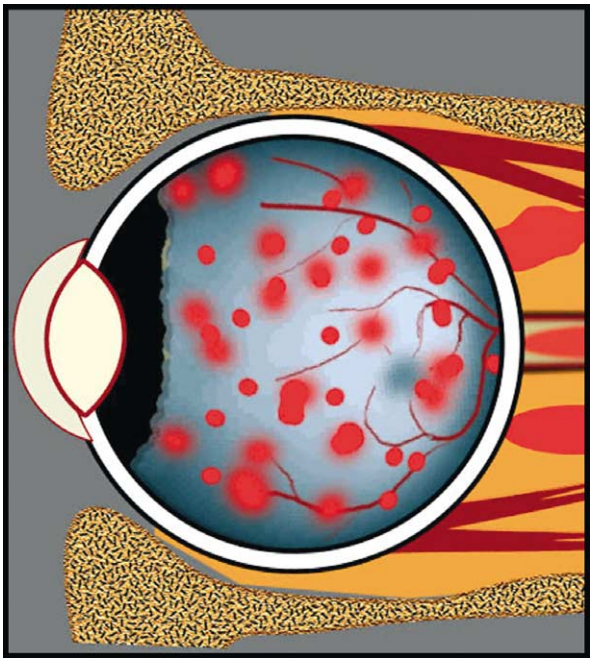

Figure 24 Pattern of retinal hemorrhages associated with severe angular/rotational trauma. Reproduced with permission of J Lauridson, © 2004.

a reliable opinion about timing in a closed-head injury case is particularly challenging, since there is a continuum of symptoms based on the severity of the head injury. In the most severe cases, where children suffer death or permanent brain impairment from the assault, forensic experts can be quite clear in stating that the child would have shown symptoms immediately and those symptoms would progress in a fairly predictable fashion over a short period of time. Even where the caretakers for the child are unwilling to describe what they saw, if they call for assistance from police or paramedics, the rapid deterioration of the child's condition is well documented from the first contact of trained professionals with the child through the hospital emergency room and through to the final outcome for the victim.

Identifying the Perpetrator

Identifying the person who caused injuries to a child is a complicated matter, which usually requires more than the forensic skill of the clinicians and pathologists involved in a case. However, the medical experts provide the most important assistance in the courtroom on the issue of identification. First, the forensic expert identifies the likely age of the injury by comparing the expected onset of symptoms with what was described by witnesses. Next, the expert narrows the "window" during which the injuries could have occurred by applying what is known about the onset of symptoms to the witnesses' descriptions of the victim's behavior. Finally, the expert may express the opinion that someone who was in the role of a caretaker for the child during that "window" of time was likely the cause of the victim's inflicted injury. The proponent of the evidence must

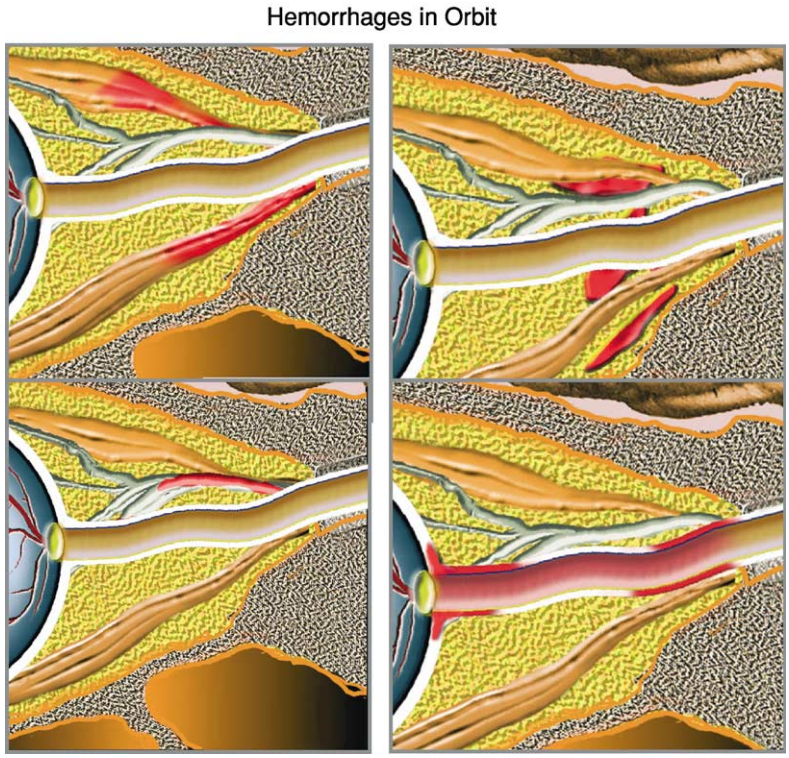

Figure 25 Images showing mechanism which causes optic nerve sheath hemorrhages anterior to the apex. Reproduced with permission of J Lauridson, © 2004.

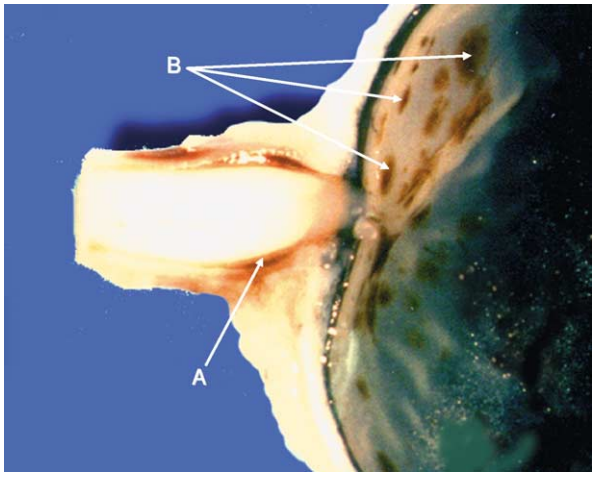

Figure 26 Autopsy photo showing both optic nerve sheath hemorrhages and retinal hemorrhages. Reproduced with permission of J Lauridson, © 2004.

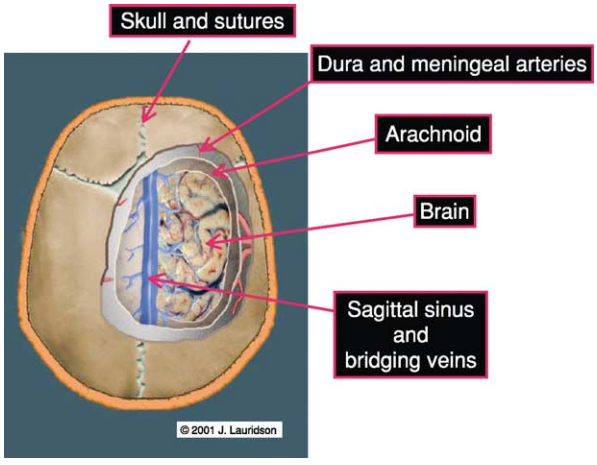

Figure 27 Computer diagram showing basic anatomy of the head from above. Reproduced with permission of J Lauridson, © 2004.

then invite the trier of fact to consider a number of factors to narrow the proof of exactly who the perpetrator was. The remainder of that proof comes from other witnesses who describe what happened to the child both before and after the child's health became compromised.

Figure 31 illustrates a simple timeline prepared by hand during the investigation when the injury occurred, based on descriptions of the child's behavior from several witnesses, then illustrates that the fatal head injury must have been inflicted while the child was alone with only one person. Figure 32 is a simple courtroom timeline suitable for use in a closing argument to illustrate what happened to the child victim, when it occurred, and who was with the child when the fatal injuries were inflicted.

Cases in which the perpetrator of abuse was a complete stranger to the child victim are quite rare.

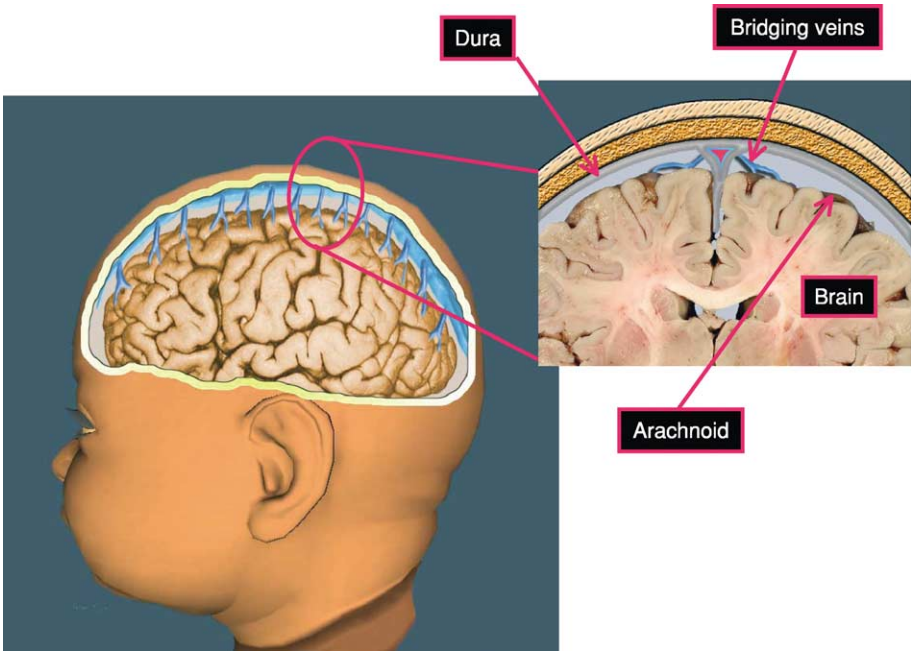

Figure 28 Lateral and coronal views of brain showing bridging veins. Reproduced with permission of J Lauridson, © 2004.

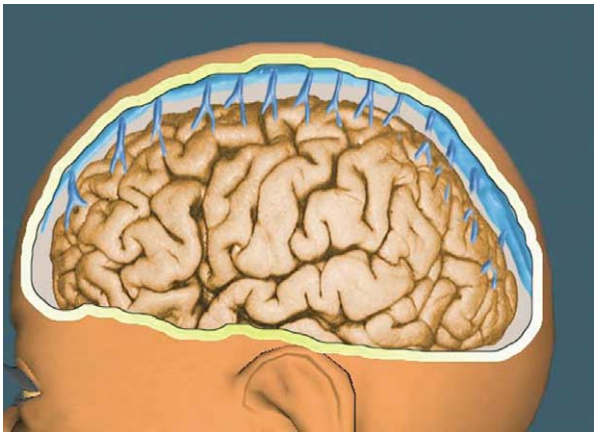

Figure 29 Mechanism of shearing of bridging veins during violent trauma. Reproduced with permission of J Lauridson, © 2004.

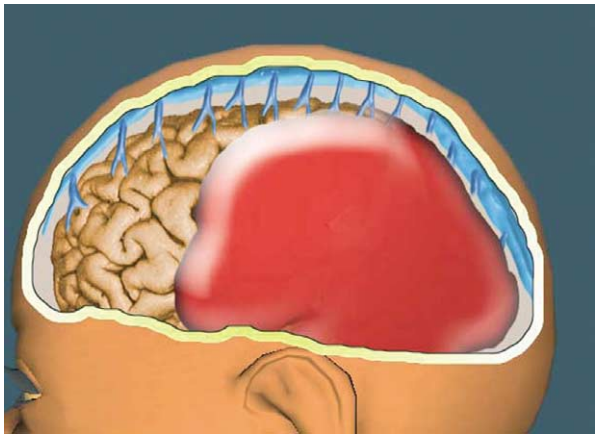

Figure 30 Collection of blood under the dura mater. Reproduced with permission of J Lauridson, © 2004.

In such cases, and assuming that the report to law enforcement authorities is made within a short time after the assault, processing the victim's body for traces of body fluids, hair, or clothing associated with the suspect may be helpful. The same is true for cases involving sexual abuse of children, although stranger abductions of children are even rarer than physical abuse or homicide committed by a complete stranger.

The Forensic Expert in Sexual Abuse Cases

Contrary to the intuitive beliefs of most members of the general public, most forms of sexual assault upon young children do not leave clear medically identified injuries which allow the forensic expert to say with certainty that the injury was inflicted by some other person. Even intercourse with young children does not always leave injuries. In addition, the younger the child, the more rapidly injuries to the anogenital area heal and since most reports are not made contemporaneously with the assault, it is often the case that no medical signs remain because of the rapid healing process. Those tasked with proving sexual abuse cases in the courtroom must use a forensic expert to explain why the absence of medically identifiable signs of injury does not rule out the possibility of the assault disclosed by the child.

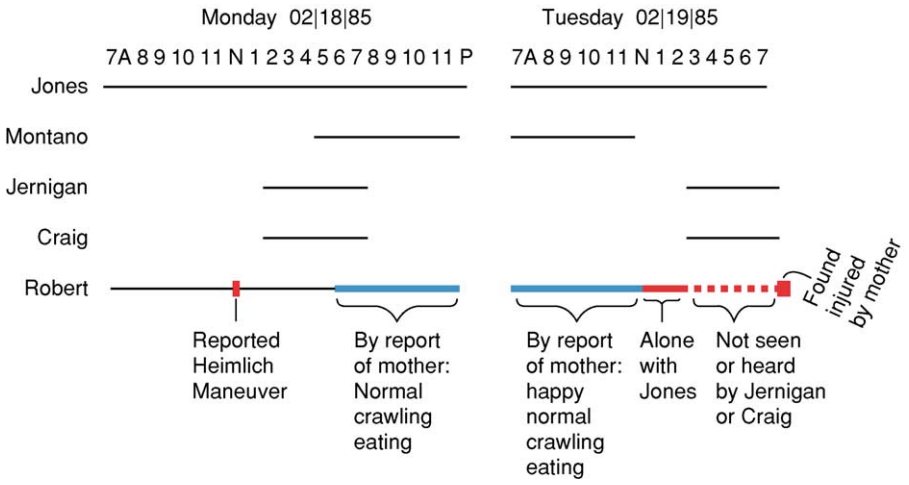

Figure 31 Investigative timeline created as each new witness is interviewed. Reproduced with permission of J Lauridson, © 2004.

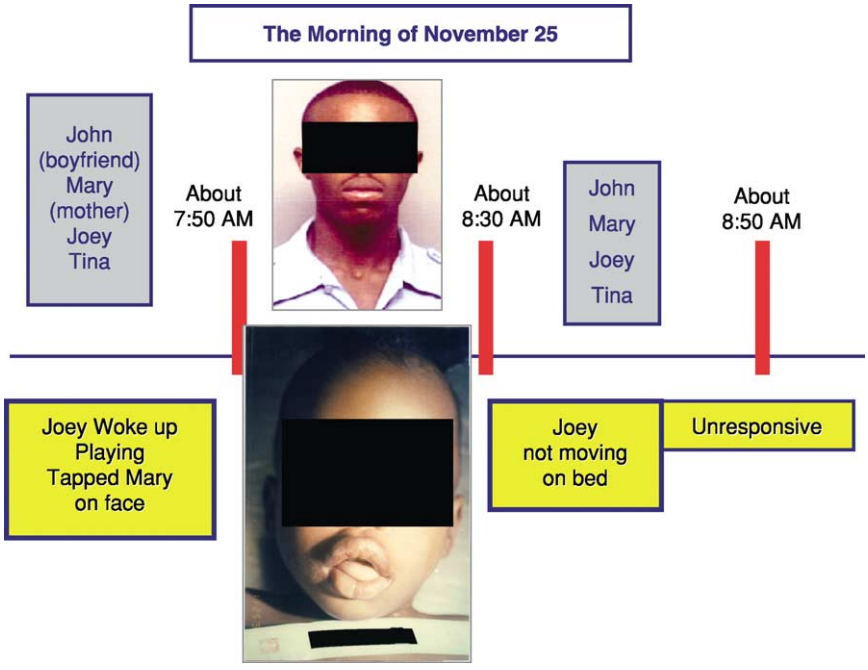

Figure 32 Courtroom timeline for closing argument. Reproduced with permission of J Lauridson, © 2004.

In general, obvious medical signs identifying sexual abuse as even a potential cause will be present in only one-third of valid cases. Those cases where the forensic expert is able to identify assault by another person as the only possible cause are fairly rare, and usually involve signs of repeated, penetrating trauma. As with physical injuries, courtroom persuasion depends upon illustration of the anatomy, especially focusing on the three-dimensional aspects of the anogenital structures. Quite often in cases involving penetrating injury to the hymen of a young girl, for instance, the claim made by the person accused of assaulting the child is that the child suffered some sort of accidental straddle injury. The well-trained expert can explain that, unless the object which the child straddled could have penetrated the outer genital structures without leaving any sign of trauma, the inner damage to the hymen with no other injuries is inconsistent with the described straddle injury. Of course, whether the child was wearing clothing and/or a diaper is also critical in considering whether penetrating injury to the internal hymen could have occurred from the straddle injury. Illustrations used to make this point must show the difference between contact with external genital structures and penetrating trauma. Figures 33–38 are simple computer-generated diagrams useful for illustrating various forms of sexual abuse of a young female child.

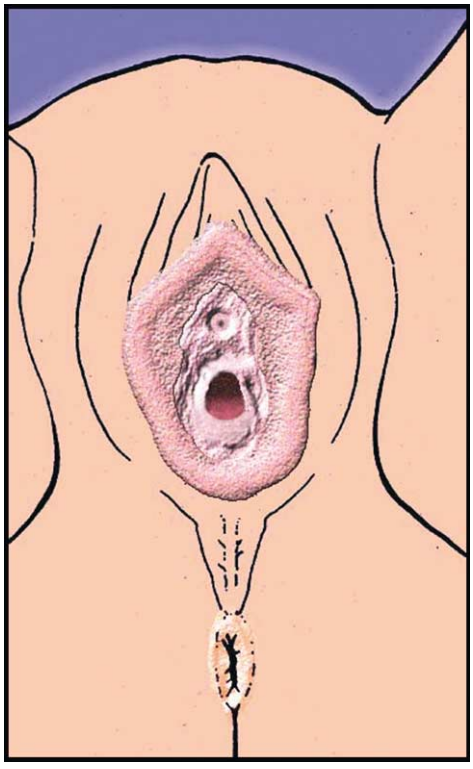

Figure 33 Basic genital anatomy, showing three-dimensional nature of structures. Reproduced with permission of J Lauridson, © 2004.

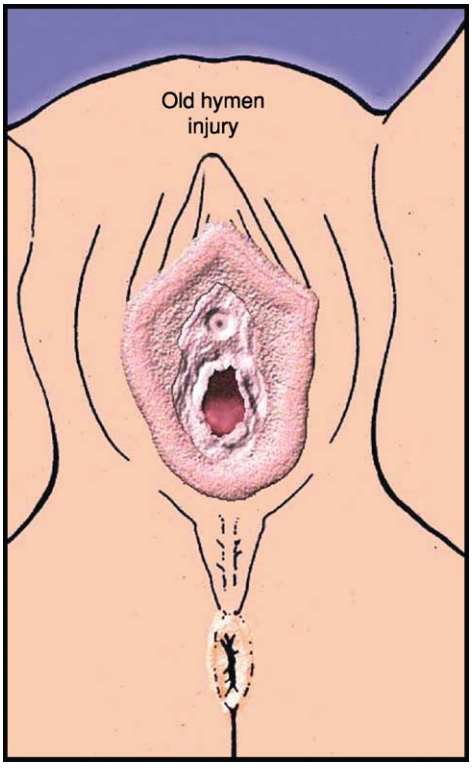

Figure 35 Diagram showing an old, healing injury to the hymen. Reproduced with permission of J Lauridson, © 2004.

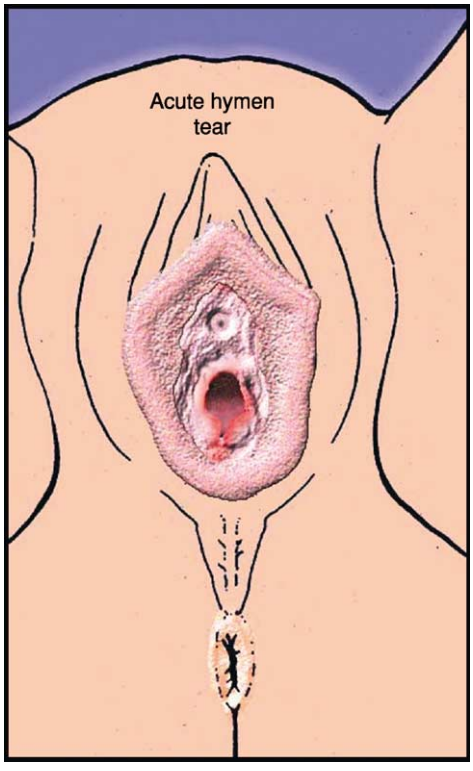

Figure 34 Diagram showing an acute tear of the hymen. Reproduced with permission of J Lauridson, © 2004.

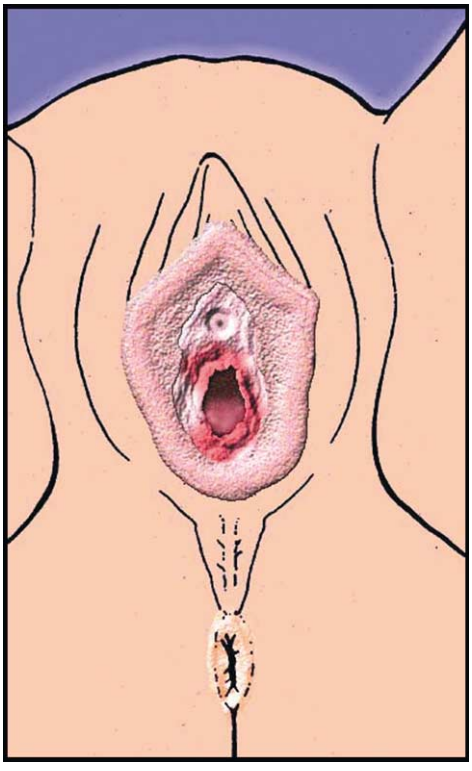

Figure 36 Redness or irritation of the hymen. Reproduced with permission of J Lauridson, © 2004.

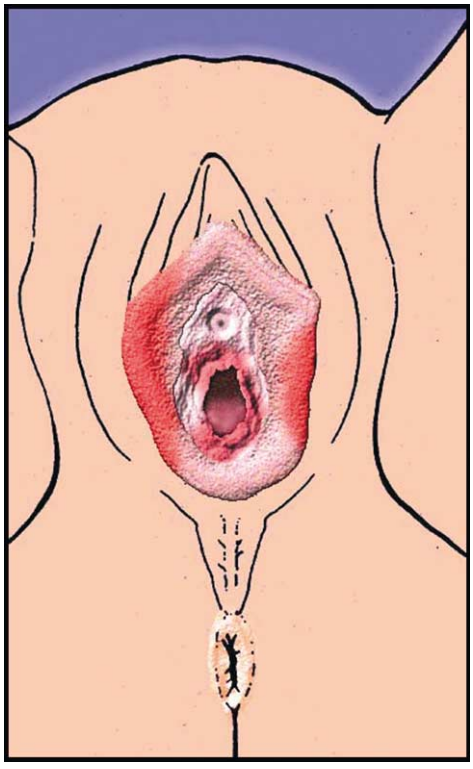

Figure 37 Redness or irritation of both labia and hymen. Reproduced with permission of J Lauridson, © 2004.

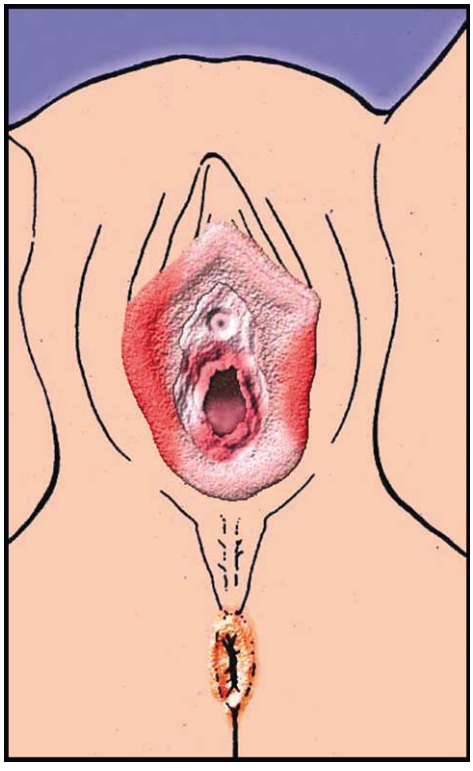

Figure 38 Hymenal injury along with anal redness and edema. Reproduced with permission of J Lauridson, © 2004.

Conclusion

Forensic medical experts have ushered in a novel era for attorneys tasked with proving all forms of child abuse in the courtroom. The collective expertise of expert pathologists in homicide cases, and of clinicians in all forms of abuse cases, is a powerful scientific basis for courtroom opinions explaining how the child was injured, when the child was injured, and in most cases the identity of the person who caused those injuries to the child. Persuasion in the courtroom now requires not only a sound scientific basis for opinions expressed, but also expert competence in educating the trier of fact concerning complex medical concepts through creative use of demonstrative materials. The combination of continued enhancement of the ability to identify the cause of injuries to children as well as to illustrate those concepts in courtrooms should result in providing justice for the youngest victims of crime.

See Also

Children: Legal Protection and Rights of Children; Sexual Abuse, Overview; Sexual Abuse, Epidemiology; **Imaging:** Radiology, Pediatric, Scintigraphy and Child Abuse

Further Reading

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Emotional Abuse

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Introduction

The psychological harm that occurs in all forms of serious child abuse, as well as that which exists as an entity in its own right, has only been systematically studied since the mid-1980s.

It is now accepted that its occurrence is central to the harm that serious abuse of any type produces in children as well as being the basis of the long-term effects of abuse.

The concepts, classification, identification, recognition, and intervention are still being researched and developed.

The material to be covered in this article includes:

- an overview of psychological/emotional maltreatment and its central role in the harm manifest by abused children
- epidemiological aspects of psychological/emotional maltreatment
- psychological/emotional maltreatment, child protection legislation and the legal system
- clinical aspects of psychological/emotional maltreatment, including its recognition and categorization.

General Concepts Related to Psychological/Emotional Abuse

The Central Position of Psychological Maltreatment in Any Type of Serious Child Abuse

Child abuse and neglect are phenomena that adversely affect children's development, and sometimes their physical well-being and survival.

Overall, most children who suffer child abuse are harmed by their primary carers, who are usually their parents. Children who experience sexual abuse invariably know the person who harmed them, but it is frequently an individual who does not have primary responsibility for their care.

When considering child abuse and neglect in general, the basic premise is that parents (the commonest primary carers of children) are responsible for ensuring that their interactions with their children are nurturing and neither abusive nor neglectful. In other words, that their care facilitates (at least) adequate growth and development of their child.

Parents may be stressed or disturbed and may find it difficult to achieve an adequate parenting role. The child for whom they are responsible may be temperamentally difficult or have a physical or psychological condition, which makes parenting arduous. The general societal expectation is that if parents are unable to manage their parenting role adequately it is their responsibility to seek assistance. If they do not, or they are unable to do so, others have the duty to intervene for the sake of the child as well as the parent.

Even though four categories of abuse are described (physical, sexual, psychological or emotional, and neglect), the harm resulting from abuse is of either a physical or psychological nature. For instance, most children who experience sexual abuse are not harmed physically. They do, however, manifest psychological harm, which is the critical issue and has significant and often serious effects over time.

Similarly, most children who are physically harmed through physical assault have no residual effects from the injuries. However, these children also suffer short- and long-term psychological effects.

Therefore, the harmful effects of abuse, manifest as the child grows and develops, emanate from the psychological damage inherent in the abusive acts and interactions.

In fact, the level of psychological maltreatment that occurs, irrespective of the abuse category present, is the best predictor of long-term adverse effects of any form of abuse.

When psychological harm occurs in association with other forms of abuse, the harmful incidents are either few in number but seriously traumatic (for example, because they threaten the child's survival) or alternatively the abuse occurs over a longer period of time, with the child being repeatedly exposed to the harmful behaviors of the perpetrator.

When children have been sexually abused the factors that will lead to psychological harm include the extent of trust betrayal experienced by the child and the level and seriousness of the threats used to ensure the compliance of the child with the abusive sexual acts.

The Emergence of Psychological Maltreatment as an Entity

With the development of a better understanding of the dynamics of physically abusive families, it became clear that physically abused children were often harmed in nonphysical ways. The harm seen in these children resulted from the damaging way in which they were parented and in the failure of their parents to meet their emotional needs.

Similarly, in children who had suffered sexual abuse, there were frequent signs of psychological or

emotional damage that resulted indirectly from the harmful behavior of the abuser.

The concurrence of psychological abuse with physical or sexual abuse is now recognized during the evaluation of physically or sexually abused children. Its presence should always be sought to ensure optimal management of the child.

Psychological harm is now well accepted as an entity in its own right and the harmful patterns of interaction between caregivers and children, which cause emotional and psychological damage, have been identified.

As with all types of child maltreatment, parenting dysfunction is central to the problem of psychological abuse, but in this form it is at its most severe. Harm to the child's emotional/psychological health results from various combinations of damaging parental behaviors and lack of parental availability or responsiveness.

Children are vulnerable to any form of abuse, including psychological, by virtue of their position of differential power compared with their adult caregiver.

Emotional–Psychological Maltreatment and Child Abuse Statistics

In child abuse data collections, the lowest rate for reporting psychological maltreatment is in the 0–2-year age group and the highest in those children 12 years or older.

Also, psychological maltreatment is up to five times more commonly reported in lower-income groups. In part this is related to the higher reporting rates of all forms of abuse in these groups. Generally psychological maltreatment is likely to be underreported unless it is linked to other forms of abuse (for example, physical or sexual abuse). It is generally considered that, in higher socioeconomic groups, verbal and other "psychological" methods are used by choice to control others. Consequently, it seems likely that psychological maltreatment would be more common in this social group. It is not established as such because of the overall lower rate of notification of suspected abuse in this social group.

Some comparison of national statistics is possible using data from the USA, Canada, England, and Australia.

Statistical collection in England is centralized, and the statistical material can be gathered in a consistent manner, with each area of the country using the same definitions and interpreting information in the same way. However, a different system of "confirmation" of abuse is used and, because there is no mandatory reporting, many children who in other countries would enter the child protection system are managed in alternative ways.

The USA, Canada, and Australia are federal systems with individual states collecting their child protection data as they see fit. This may contribute to interstate variation in data but the overall outcome can generally be regarded as representative of the respective country as a whole.

English Data

In England children are designated as "in need" and may then be entered on the child protection register after a multidisciplinary case conference. Inclusion on the child protection register is the closest equivalent to the category "abuse substantiated," that is used in other countries. Overall, the rate of children to age 16 years on the child protection register is 4/10 000.

Since 1998 the proportion of children on the register under the category "emotional abuse" has been fairly stable at between 16% and 18%. Emotional abuse is most prevalent in the 5–15 year age group (21% of those on the child protection register are in this age range). In each age group neglect remains the most common reason for children to be on the register.

US Data

Child abuse statistics in the USA are compiled from individual states. The published figures from 2001 show that 3 million children were subject to a child protection investigation and 30% of these were considered to be victims (i.e., the abuse was considered substantiated). Children who were victims of psychological/emotional abuse comprised 6.8% of victims, compared with 59.2% who were considered victims of neglect. In 2001 the rate of psychological maltreatment was 0.9/1000 (a constant rate since 1997).

Canadian Data

The Canadian *Incidence Study of Reported Child Abuse and Neglect* relates to data collected from the Canadian provinces in 1998, when a total of 135 573 children were subject to a child protection investigation. Child maltreatment was substantiated in 45% of the investigations. Emotional maltreatment was one of the four primary categories (i.e., physical abuse, sexual abuse, neglect, and emotional maltreatment) and comprised 19% of the investigations.

Fifty-four percent of the investigations into suspected emotional maltreatment were substantiated (compared with a substantiation level of 34% for suspected physical abuse, 38% for sexual abuse, and 43% for neglect).

Australian Data

The Australian child protection statistics for the financial year 2002–2003 (July 1, 2002–June 30, 2003)

show that over this year 198 355 notifications of suspected child abuse were made and 66 456 investigations finalized (these were the notifications considered necessary to investigate). The substantiation rate overall was 33.5% but was 60.4% for those notifications that were considered necessary to investigate.

Overall, emotional abuse comprised 34% of the substantiated cases, compared with 27.8% for neglect and physical abuse and 10.2% for sexual abuse.

Psychological Maltreatment and the Legal System

Following the first modern description of physical abuse, which occurred in the late 1960s, it became clear that specific child protection legislative provisions needed to be introduced to enable the state to intervene to protect children who had been abused or who were considered to be at high risk of abuse.

Child protection legislation also led to the establishing of state statutory agencies whose primary responsibility was and remains the assessment of children suspected of having been abused and their subsequent protection from further abuse, if needs be through court action.

Child Protection Legislation and Psychological/Emotional Maltreatment

The primary purposes of child protection legislation are to provide a legal basis for receiving notifications of suspected abuse; to authorize the assessment of children in whom abuse is suspected; to guarantee the ongoing safety of children, either through placement outside their family of origin or successful intervention within their family of origin, to ensure that further abuse does not occur; to ensure that, when necessary, legal intervention is appropriate and optimal; to organize the provision of appropriate therapeutic services directed at helping the child resolve the effects of abuse.

The central focus in the development of child abuse definitions is whether the primary emphasis should be on the maltreating behavior of the carers, or the consequences of the behavior on the child. For instance, sexual abuse is usually defined in terms of the maltreating behavior (the child being subjected to inappropriate sexual contact), whereas physical abuse is defined by the outcome for the child, namely physical injury.

Child Protection Legislation and the Categorization of Child Abuse

In most jurisdictions child protection legislation defines physical abuse, sexual abuse, emotional or psychological abuse, and neglect. Such categorization is not meant to imply that abuse of different forms does not occur in the same child; in fact more than one category of abuse can be identified in most abused children. Legal intervention in cases of child abuse in part depends on how closely the situation of suspected harm matches the abuse definitions incorporated in child protection legislation. Therefore, reports of child abuse tend to be assessed categorically, reflecting the requirements of legal definitions.

Categorization of abuse is also important in those jurisdictions where the legislation incorporates the concept of "mandatory reporting." Mandatory reporting refers to the legal requirements placed on certain individuals, usually professionals, to report to a specifically identified agency any child in whom the mandated notifier has reasonable grounds to believe abuse has occurred. Sometimes, the legislative requirement is broader, and includes those children in whom abuse is considered highly likely to occur. The categories and definitions of abuse present in child protection legislation give guidance to mandated notifiers in the identification and then the reporting of suspected abuse.

Whether or not child abuse (of any category) has occurred is not predicated on the intent by the abuser to harm the child. Therefore, legislative definitions of abuse do not include any intentional requirements. This does not mean that intentional acts of child abuse do not occur but intent is not required either for abuse to be suspected or confirmed. Generally speaking, the level of intent associated with abusive acts is an indication of the seriousness of the abuse.

Usually child protection legislation incorporates the concept that behaviors are abusive when they are outside the norm for the accepted community standards of parent–child interaction. This concept is particularly relevant when considering emotional or psychological maltreatment. The parental behavior involved may not be considered abusive when it occurs as an isolated event but is harmful when it is repetitive and occurs consistently.

The legislative emphasis in the definitions that form the basis for assessment and intervention in suspected cases of psychological maltreatment varies between:

- the evidence of harmful behaviors by parents
- the evidence of harm to the child
- a combination of both.

In most jurisdictions the legislation will require that to substantiate that psychological maltreatment has occurred, it is necessary to show both ill-treatment by the parents and evidence of harm in the child.

This may limit the provision of intervention services to families where parental behaviors have the

potential to harm but the effects on the child are not yet obvious.

Clinical Aspects of Psychological Maltreatment

The Development of a Suspicion That Psychological Maltreatment Is Present

The recognition of physical abuse depends on the presence of suspicious injury; sexual abuse is most often recognized after an allegation has been made by the child. Because psychological maltreatment has no external physical signs and children who experience it are not usually aware of the abusive nature of their parents' interactions with them, the suspicion that psychological abuse is occurring in its own right is based primarily on observations of, or reports of, harmful patterns of repetitive parent–child interaction.

Psychological maltreatment refers to the harm caused to a child's mental or emotional state by abusive caregiver behaviors. Generally, psychological maltreatment in its extreme forms is referring to harmful patterns of behavior that are repetitive and convey to children that they are worthless, and neither wanted nor loved. This produces a belief in children that their only value is in meeting their parent's needs.

A child is also indirectly psychologically harmed by serious threats imposed by another on the person with whom the child has established a primary relationship (usually the mother) and other loved ones. Such harm most commonly occurs in situations of family violence.

Those who work with children and families have been aware for many years that certain forms of parent–child interaction cause obvious distress and potential harm to children. The commonest and most obviously damaging parental behavior of this type recognized is verbal abuse, which ridicules and belittles a child.

When a child has been psychologically abused, the "evidence" of harm is not always apparent. Signs of harm include a deterioration in, or lower than expected, cognitive function, and an immaturity, and therefore vulnerability, in the child's capacity to manage social or emotional challenges competently. Children who have been psychologically harmed are not usually aware themselves of the harm to which they have been subject. Compared with the obvious injury of a physically abused child and the allegations made by sexually abused children that bring to light the harm they have suffered, the recognition of psychological maltreatment depends on observations of potentially harmful parental behavior linked with the manifestations of harm seen in the child.

The Terminology That Describes Inflicted Psychological Harm

In general terms, "emotion" refers to a mental feeling or affection, whereas "psychology" refers to the cognitive or volitional states of consciousness that affect the attitude or outlook of an individual. It has been suggested that emotional and psychological abuse should be distinguished from each other. However, there is a close interdependence between cognition and emotion and this distinction is no longer considered useful.

The most acceptable and appropriate term is considered to be psychological maltreatment or abuse.

A Framework for the Recognition and Definition of Psychological Maltreatment

When considering psychological maltreatment the following issues need to be addressed.

First, the parental behaviors that cause psychological or emotional harm in children do so when they are sustained and repetitive. They do not necessarily produce any significantly adverse effects when occurring intermittently in the context of an otherwise satisfactory parent–child relationship. Therefore, definitions of psychological maltreatment should incorporate the concept of threshold of harmful parenting behavior, above which intervention on the child's behalf should be considered and below which intervention should be directed at improving the parent–child relationship.

Second, some of the behavioral and developmental consequences of psychological maltreatment are seen in children in whom psychological maltreatment cannot be established. Therefore, such behaviors and developmental disturbances should only be attributed to psychological maltreatment when the harmful parental behaviors are apparent.

Psychological maltreatment indicates the presence of a harmful relationship between the parent and child. The American Professional Society on the Abuse of Children states that: "Psychological maltreatment means a repeated pattern of caregiver behavior or extreme incidents that convey to the caregiver's children that they are worthless, flawed, unloved, unwanted, endangered, or of value only in meeting another's needs."

This definition is linked by the American Professional Society on the Abuse of Children to six forms of psychological maltreatment:

1. spurning (verbal and nonverbal hostile rejection or degradation)
2. terrorizing (behavior that threatens or is likely to harm physically the child or place the child or the child's loved objects in danger)

3. exploiting/corrupting (encouraging the child to develop inappropriate behaviors)
4. denying emotional responsiveness (ignoring the child's need to interact, failing to express positive affect to the child, showing no emotions in interactions with the child)
5. isolating (denying the child opportunities for interacting/communicating with peers or adults)
6. mental, health, medical, or educational neglect (ignoring or failing to ensure provision of the child's needs).

These six categories of psychological maltreatment describe patterns of parental behavior which, when repetitive and severe, will significantly harm a child. Even though each of these categories of psychological maltreatment contains a continuum of seriousness of behavior, from minor to serious, they tend to be used to describe the most serious occurrences of psychological abuse, those in which legal intervention is usually considered necessary.

For lesser degrees of psychological maltreatment, when a mental health approach rather than legal intervention is indicated, an alternative system of categorization of psychological maltreatment may be found useful. This approach is particularly helpful in planning interventions. As previously mentioned, the carer behaviors that have been identified as emotionally/psychologically harmful to children have their most detrimental effect when they are repetitive and inflicted with intent to harm.

The severity of psychological maltreatment is then established by a combination of the intent to psychological abuse and the level of resulting harm in the child.

The least severe form of psychological abuse is not associated with intent and is not likely to lead to harm. For example, the isolation imposed on a child through parents resorting to time-out or grounding is not intended to cause harm and will not unless it becomes repetitive and intended to harm.

Moderately severe psychological abuse is associated with a significant level of malicious intent and is therefore associated with a high probability of harming the child.

Severe psychological maltreatment occurs when the repetitive, harmful acts are malicious and continue to occur with the abuser knowing that they are harmful. Inherent in the following alternative categories of psychological maltreatment is the lack of intent by the carers in the harmful acts they inflict upon their children. The lack of intent indicates that a mental health rather than legal intervention approach is more appropriate. If, in the process of intervention it is discovered that intent to harm is present in the maltreating behaviors then legal intervention must be considered.

The following five categories overlap with the six APSAC categories. They are given as follows.

1. Lack of emotional availability and responsiveness. Primary carers in this category often have significant mental health problems or are substance abusers. Therefore, they are not able to respond to their child's emotional needs adequately. It is important to note that sometimes, although one primary carer is unavailable, another is able to meet the child's needs. In such a situation there is no evidence of significant harm manifest by the child. Intervention should focus on the psychosocial circumstances of the potentially abusive carer.
2. Lack of positive attribution to or acknowledgment of the child. There is a significant level of denigration and rejection focused on the child. However in this context, it is not consistently present and is not associated with intent. When the child is perceived by the carer to be deserving of such treatment and it is persistent and pervasive, then legal intervention must be considered necessary.
3. Interactions with the child, which are developmentally inappropriate or inconsistent. These carer behaviors are typified by either the expectation that a child should be involved in matters that are more the responsibility of adults or by failing to acknowledge the need for a developing child to have appropriate freedom to participate in independent activities and explorations. Examples include carers who burden young children with their own emotional or psychosocial difficulties and carers who oversee their child to the extent that little developmentally appropriate exploration or self-learning is possible.
   When the developmentally inappropriate behaviors involve the exposure of the child to traumatic events (for example, repeated episodes of domestic violence), then the harm which invariably occurs indicates that the psychological abuse is serious and that legal intervention must be considered.
4. Lack of regard for the child's individuality and own psychological boundaries. In its most severe form this category of maltreatment includes illness induction or symptom fabrication, so-called Munchausen syndrome by proxy. The harm associated with this degree of psychological maltreatment invariably indicates that legal intervention is necessary. However, when physical or psychological symptoms are exaggerated or carers become preoccupied with their child's health and well-being, to the detriment of the child's emotional and psychological state, then a mental health

approach is appropriate. The transition point between these two extremes occurs when the carer does not respond to planned intervention, persistently and vigorously exposes the child to repeated medical assessments, and insists on lines of medical management not indicated by the child's clinical condition.

5. Disregard for the child's need for social adaptation. When a carer fails to supervise a child adequately so that the child is adversely affected by corrupting and other missocializing experiences, nonlegal intervention may be appropriate if the carer accepts the inappropriateness of his/her acts of omission. However, active corruption of children (for example, by having them involved in overtly criminal behavior) requires legal intervention.

Stepwise Approach for Managing Suspected Psychological/Emotional Maltreatment

1. Establish the presence of harmful/potentially harmful carer behaviors:
   a. reported
   b. directly observed.
2. Define the nature of the carer–child interaction and the adequacy of the level of physical and psychological care in the context of the harmful/potentially harmful carer behaviors.
3. Consider the presence/absence of intent to harm in the harmful/potentially harmful care behaviors:
   a. intent to harm present – notification to statutory authority
   b. intent to harm absent – mental health-based management.
4. Mental health management:
   a. establish the level of carers' acceptance of their harmful/potentially harmful behaviors towards their child
   b. review the child's need for protection and the psychological adequacy of the child's care environment
   c. formulate a program of intervention.

See Also

Children: Legal Protection and Rights of Children; Physical Abuse; Sexual Abuse, Overview; Sexual Abuse, Epidemiology

Further Reading

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Physical Abuse

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Introduction

Physical abuse of children is a common problem worldwide. The definition of physical abuse may vary from one culture or community to another. For example, physical punishment of children is outlawed in some countries, while other countries have few barriers to families administering draconian punishments to their children. In countries with organized child protection laws and systems, the medical examination and documentation of inflicted injuries to children are important for the children's protection. The recognition and documentation of abusive injuries are needed in cases involving living children as well as in child homicide cases. In addition to forensic pathologists, many other types of physicians and nurses require expertise in caring for abused children.

The World Health Organization (WHO) defines the physical abuse of a child as "that which results in actual or potential physical harm from an interaction

Table 1 Risk factors identified in studies of physical child abuse

Victim characteristics
Male sex
Premature birth
Age under 4 years
Minority race
Physical or mental handicap
Family characteristics
Poverty
Unmarried parents
Unrelated male living in household
Maternal depression
Intimate partner violence between adults in household
Young maternal age
Offender characteristics
Male sex
Unemployment
Substance abuse
History of abuse in childhood

or lack of interaction, which is reasonable within the control of a parent or person in a position of responsibility, power, or trust." WHO considers children to be human beings below the age of 18 years. They estimate that worldwide 57 000 children under 15 years of age die yearly as a result of child abuse. The homicide rate for children under 5 years of age is twice that of children 1–14 years of age. Nonfatal abuse occurs much more frequently. Abuse can lead to disabling physical and mental illness. The cost to society of caring for victims of childhood physical abuse has never been estimated.

While no "profile" of child abusers can be assumed, several risk factors for victimization have been identified. Table 1 includes generally accepted epidemiologic factors that have been identified to be associated with increased risk of physical abuse.

This article will address the general principles in the diagnosis of physical abuse, including taking a history, performing physical examinations, recommended radiologic examination, photodocumentation, and medical chart documentation. Following this, abusive injuries will be discussed by organ system. Finally, the role of medical personnel in the multidisciplinary evaluation of child abuse will be discussed, and the need for cooperation and communication between disciplines will be emphasized.

Medical and Forensic Evaluation of Cases of Suspected Physical Abuse

The Medical History

General principles It is important to obtain a careful medical history in any case of suspected physical abuse. Generally, caretakers are interviewed separately. For medical professionals, a caring, nonjudgmental approach should be used. Since many medical conditions can mimic child physical abuse, the history must be comprehensive. The components of the complete history are as follows. At the end of the interview, caretakers should be given the opportunity to ask questions and to express their opinions about what they think is wrong with the child.

History of the presenting symptoms or injuries The history of the current event should begin before the child became symptomatic. The time previous to the onset of symptoms is documented, including the child's activities, level of alertness, sleep patterns, meals, bowel movements, vomiting, and mood. Was some precipitating event noted, such as a fall, a tantrum, or a sudden change in affect or activity level? When was the child last noted to be completely normal? What was the first change noted? How have symptoms changed over time?

When documenting the period after the child became symptomatic, the interviewer should review each change in status and document the surrounding events. Where was the child when changes in status occurred? Who was with the child? What was the child doing? How was the child functioning? This minute-by-minute history of every aspect of the child's life during this time can lead to important information about what actually happened to the child.

Past medical history The entire medical history should be reviewed, starting with the mother's pregnancy. Was the pregnancy planned? Was the pregnancy welcomed? Did the mother consider terminating the pregnancy? A history of the mother's symptoms and illnesses during pregnancy as well as any complications should be documented, as well as her use of medications, drugs, and alcohol, or other toxic exposures. Record mother's weight gain during pregnancy and when and if prenatal care was sought.

The labor and delivery history is next obtained, including complications, procedures, Apgar scores, need for resuscitation at delivery, problems in the newborn nursery, length of hospitalization, and birth weight.

The child's entire medical history should be reviewed, including illnesses, growth, immunizations, medications, and allergies.

Emotional, behavioral, and developmental history The course of the child's development, including school performance and achievement, can influence the evaluation of presenting signs and symptoms.

Delayed development may be a sign of underlying illness, previous injury, or environmental deprivation. The appropriateness of the child's emotional attachment and bonding should be explored. Behavioral problems or disorders can increase the risk of abuse, or may be the result of ongoing abuse.

Nutritional history Take a history of regular intake, type of feeding (if infant), diet characteristics, and food intolerance.

Family history It is important to record a family history of unusual illness. Include a history of genetic or inherited disorders, premature deaths and sudden infant deaths, fetal wastage, consanguinity, unusual bleeding problems, brittle bones or tendency to fracture easily, poor wound healing, early teeth or hearing loss, and mental retardation.

Social history The level of family functioning should be assessed, including employment, economic stress, substance abuse, marital dysfunction, criminal history, and domestic violence. Potential family stressors should be identified, and sources of family support documented, including financial resources, extended family support, housing, and community support.

Environmental history While the medical practitioner would rarely conduct a home visit, others can provide information about the child's environment, including temperature, unsafe conditions, exposure to toxins such as lead or carbon monoxide, overcrowding, the safety and quality of housing, the general level of cleanliness and order, and adequacy of the home's condition.

Physical Examination

A careful head-to-toe examination is critical, including vital signs, measurement of height, weight, head circumference, height-to-weight ratio, and body mass index. Description of the child's affect and state of consciousness is noted. As part of a good physical exam, a careful genital and anal exam is necessary. In suspected head trauma cases, an indirect ophthalmoscope examination done by an ophthalmologist is indicated. Any suspicious skin lesions are carefully documented and photographed. When bruising is noted, serial examinations over time are required to document progression of the lesions. A rape kit is performed if sexual assault is suspected.

It is important not to miss physical findings that might not be obvious, including scalp trauma, pulled hair, bruising behind the ears or of the pinna, blood or effusions behind the tympanic membrane, scleral lesions, trauma to the pharynx, mouth, teeth or frenula, crepitus over ribs or long bones, or signs of abdominal or chest trauma.

Review previous growth parameters if the child's growth is abnormal to aid in diagnosing chronic neglect or failure to thrive.

Radiologic Studies

A radiographic skeletal survey should be done in all cases of suspected physical abuse in children under 2 years of age. In children between 2 and 5 years of age, it is less useful, although may be used when occult fractures are suspected. It is not likely to be useful in children over 5 years of age. Table 2 lists the parameters of an adequate skeletal survey. Repeat skeletal surveys done 2 weeks after the initial survey may increase the yield of occult fractures diagnosed, because some very new fractures are sometimes difficult to visualize radiographically.

Radionuclide bone scans may be a useful adjunct to skeletal survey, but should not replace the skeletal survey. Any positive findings should be confirmed with radiography.

Computed tomography (CT) is the modality of choice for the initial evaluation of suspected abusive head trauma. Magnetic resonance imaging (MRI) should be done at 5–7 days postinjury because it is more sensitive and specific for diagnosing subacute and chronic head injuries. Techniques useful in diagnosing abusive head trauma include T_1 and T_2 weighting with proton-density or inversion-recovery sequences, gradient echo sequences, and diffusion weighted images.

Table 2 Parameters of the skeletal survey

Required images	
Views of appendicular skeleton	*Views of axial skeleton*
Humeri (AP)	Thorax (AP and lateral)
Forearms (AP)	Pelvis (AP; including mid and lower lumbar spine)
Hands (oblique PA)	Lumbar spine (lateral)
Femurs (AP)	Cervical spine (lateral)
Lower legs (AP)	Skull (frontal and lateral)
Feet (AP)	
Technique	
Use high-resolution film (spatial resolution of at least 10 line pairs per millimeter)	
Screen/film speed not to exceed 200	
Low kVp (bone technique)	
Single emulsion or special film-screen combination	

Reproduced with permission from American Academy of Pediatrics Section on Radiology (2000) Diagnostic imaging of child abuse. *Pediatrics* 105: 1346.
AP, anteroposterior; PA, posteroanterior.

Table 3 Laboratory evaluation of suspected physical abuse

Test	*Purpose*
Blood count	Screens for anemia and unsuspected disease, helps determine cardiovascular status
Urinalysis	Screens for occult renal trauma
Liver function studies	Screen for occult liver trauma
Amylase	Screens for occult pancreatic trauma
Calcium, phosphorus, vitamin D	Screen for metabolic bone disease
Coagulation studies	Determines coagulation status. May include partial thrombin time, prothrombin time, platelet count, bleeding time, tests for activated coagulation
Urine organic acids	Screens for metabolic disease in cases of suspected head injury
Electrolytes and pH	Determine fluid status

Trauma to the thorax and abdomen is best imaged by CT. Upper gastrointestinal studies and abdominal ultrasound may be useful in specific situations.

Laboratory Evaluation

When physical abuse is suspected, certain laboratory tests will be helpful in confirming the diagnosis, detecting occult injury, and ruling out medical conditions that might mimic abuse. Table 3 lists these tests and describes the role of each test. The list is not exhaustive. Individual cases may require other diagnostic tests, depending on the clinical presentation.

Photodocumentation of Physical Abuse

When physical abuse is suspected, liberal use of photographs of visible lesions is an important part of the medical and forensic work-up. Digital cameras, film cameras, and video cameras have all been shown to be useful. It is important that the photographer has adequate equipment and training before taking the responsibility of documenting abusive injuries.

All photographs should be carefully identified and labeled, including the time and date of the image. Using multiple exposures and magnification levels can increase the yield of useful photographs. Size and color standards should be included in the field. Images should be labeled with the name of the subject, as well as with other identifying data. On anatomic images, a referential body part should be included to orient the viewer.

Generating the Medical Record

Generating a complete record is an important part of the forensic work-up in cases of suspected child abuse. Histories should be carefully documented. The source of the information recorded should be noted. Direct quotes from the victim can be archived in the record. Drawings of physical findings should supplement physical descriptions. A carefully constructed and preserved record can be helpful in substantiating abuse cases.

Physical Injuries Resulting from Abuse

Any injury can be the result of an accident, and any injury can be the result of physical abuse. However, certain types of injury have been noted to be more frequently caused by child abuse. In evaluating the cause of any injury, the history, the forces involved, and the circumstances of the injury should be carefully evaluated. The following injuries will be discussed by body region.

Abusive Head Trauma

Trauma to the head and central nervous system is the most fatal type of child abuse, especially in infants and small children. Several types of trauma may involve the head and central nervous system.

Traumatic alopecia and subgaleal hemorrhage Traumatic alopecia results from traction or pulling on the hair (Figure 1). The child is left with bald

Figure 1 Traumatic alopecia resulting from traction or pulling on the hair.

patches on the scalp where the hair grows back readily. Small petechiae may be seen at the site of the avulsion of hair roots. Traction on the scalp can also cause bleeding under the scalp (subgaleal hemorrhage) and separation of the aponeurosis through accumulation of blood. In children, large amounts of blood can be lost into the subgaleal space, leading to significant anemia.

Epidural hematoma Epidural hematomas in children are more likely caused by accidental trauma. About 5% of epidurals are the result of child abuse. An epidural can occur even in the absence of skull fracture because of the malleability of the developing skull. Blunt trauma can cause significant in-bending of the skull, damaging the vessels below the skull. The onset of symptoms following an epidural hematoma may be delayed hours to days. Epidural hematomas are commonly the cause of "lucent intervals" after head injury, followed by delayed development of serious symptoms.

Subdural hematoma Subdural hematomas can be caused by blunt trauma and/or rotational acceleration and deceleration of the head (Figure 2).

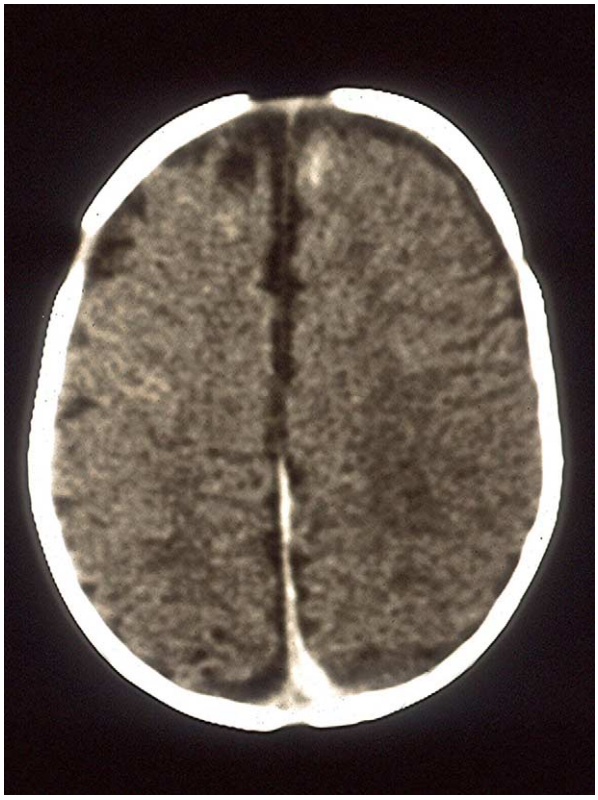

Figure 2 Subdural hematomas from abusive head trauma seen on magnetic resonance imaging of the head.

In infants and small children, subdural hematomas are commonly the result of inflicted injuries. The bleeding occurs between the dura mater and the arachnoid layer of the meninges. Rotation of the head causes rupture of delicate vessels between the two layers. Acute hematomas can be quickly resorbed, or can lead to the formation of hygromas in the subdural space, which can lead to the formation of chronic subdural effusions of high-density, protein-rich fluid. In infants, chronic subdurals can expand because of the plasticity of the skull, leading to rapid growth of the head (Figure 3).

Subdural hematomas caused by abusive head trauma are more likely to extend into the midline falx cerebri. Posterior fossa subdurals are also more common in inflicted injuries.

Preexisting subdural hematomas are known to be susceptible to rebleeding with fairly minor trauma. These rebleeds rarely lead to a change in the child's neurologic status unless a large amount of fluid accumulates, leading to increased intracranial pressure.

Dating subdural hematomas by imaging studies is problematic. Often very acute subdurals can appear on CT and MRI scans as fluids of two different densities because of the separation of formed and liquid components of blood.

Abusive brain injuries Brain injury can result from abusive head trauma. Diffuse brain injuries range from concussion (a change in physiologic and neurologic function without obvious changes on imaging studies) to diffuse axonal injury (disruption of axons in the subcortical white matter). Diffuse axonal injury can be detected postmortem using specific stains for beta-amyloid protein precursors.

Figure 3 Chronic subdural effusions causing unusual expansion of the infant skull.

Cerebral edema causes secondary injury to the brain as intracranial pressure increases, decreasing cortical blood flow. After brain injury, a cascade of neurotoxic chemicals is released from the injured tissue, leading to further brain injury.

In addition to diffuse injuries, focal contusions and hemorrhage can occur in the brain tissue. A common finding in abusive head trauma is "gliding contusions" or "gray–white-matter shearing tears" (Figure 4). These lesions occur at the gray–white-matter junction, often in the cortical frontal lobes. The lesions are thought to be caused by the different tissue densities moving at different rates during rotational acceleration.

Recent research has focused on the changes in the cervical cord seen after violent shaking of infants. Subtle signs of axonal injury can sometimes be found in the cord at the cervicomedullary junction, where the brainstem becomes the spinal cord (Figure 5). These injuries are hypothesized to cause apnea that leads to severe, diffuse cerebral edema and extensive brain damage in infants who have been violently shaken. To diagnose these injuries, the brain and upper spinal cord must be removed *en bloc* at autopsy, and section must be taken through the junction for microscopic examination.

Shaken-baby syndrome Shaking as a mechanism for causing brain injury has been reported in the literature on many occasions. In spite of a wealth of clinical data that exists, there is some doubt whether shaking alone can cause brain injury, or whether impact is also required. Newer anatomic testing devices and computer models have reaffirmed the dangers of shaking. Certainly, shaking and impact are both likely to be dangerous in infants and young children. By using the term "abusive head trauma," the mechanism of injury is not presumed. The concept of shaken-baby syndrome remains useful, especially in the context of child abuse prevention.

Shaking is thought to be the mechanism of formation of the extensive retinal hemorrhages often found in infant victims of abusive head injury (Figure 6). The hemorrhages characteristically involve multiple layers of the retina and extend throughout the retinal surface out to the ora serrata. These hemorrhages are

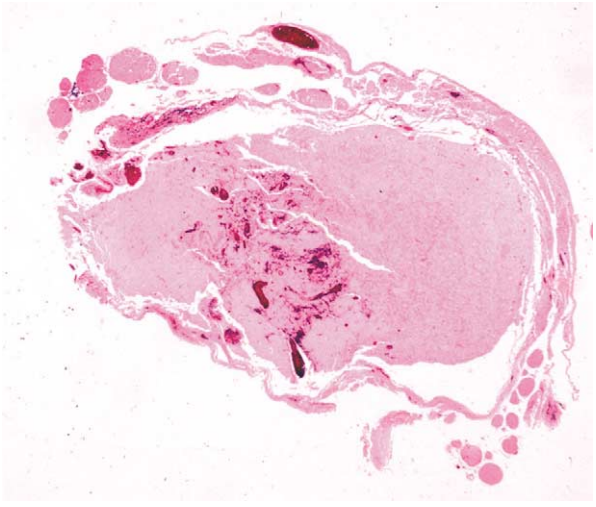

Figure 5 Photomicrograph of axonal injury found at the cervicomedullary junction in an infant who was violently shaken.

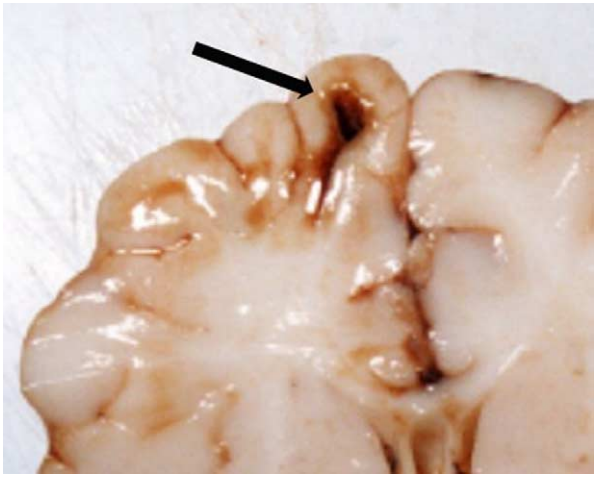

Figure 4 Gliding contusions (gray–white-matter shearing tears) of the brain tissue found at autopsy in an abused infant (arrow).

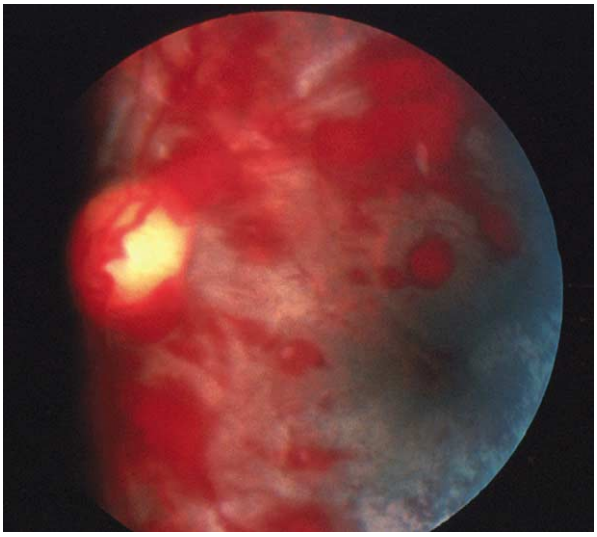

Figure 6 Extensive retinal hemorrhages characteristic of the findings in shaken-baby syndrome.

not isolated to the posterior pole of the retina alone. Detachment or folding of the retina can also occur, leading to retinoschisis.

Abusive Skin Injuries

Bruises Injuries to the skin and soft tissues are common manifestations of abuse. Accidental bruises are more likely to be located on the lower arms and legs of children. Bruising is rarely found on nonabused infants who are not yet pulling to standing. The appearance of bruises is influenced by many factors, including the depth of the bruise, the amount of blood pooling to form the bruise, the thickness of the skin in the bruised area of the body, and the status of circulation to the body part. Yellow coloration is not likely to be seen in a bruise before it is 18 h old.

Pattern marks Abusive skin injuries will sometimes resemble the object used to inflict the injury (Figure 7). Hand prints can appear as the outline of the hand on the child's face or body. Careful measurement and examination of pattern marks can lead to the discovery of the offending object in the child's environment.

Burns Burns are often associated with child abuse or neglect. Immersion burns are the most common type. Typically the child will show clear lines of demarcation with few splash marks (Figure 8). A careful investigation, including measuring the water temperature and flow rate of the water at the scene of the event, is needed to analyze the purported mechanism of the burn. Often abusive scald burns appear in a "stocking or glove" pattern on the affected extremity.

Figure 7 Pattern marks on a child's face caused by hitting the child with a hand.

Hot objects, such as lighters, cigarettes, or kitchen implements, can be used to inflict burns on children, leaving a pattern of the hot object on the skin (Figure 9).

Figure 8 Abusive immersion burns. Note the clear demarcation between burned and normal skin, and the absence of splash marks.

Figure 9 Inflicted burn on a child's face caused by applying a hot cigarette lighter.

Abdominal and Chest Injuries

Hitting, kicking, or throwing a child can cause injuries to the thorax and abdomen. The mortality rate from abusive injuries to these body regions is generally higher than it is in accidental injuries. Liver lacerations or contusions, splenic lacerations, pancreatic injury, and stomach and bowel lacerations and hematomas have all been described as resulting from abuse. Kidney and adrenal injuries are less commonly seen. All these injuries can be "silent" and not obvious on initial evaluation. A careful trauma work-up is important in cases of suspected abuse.

Lung contusions and lacerations, pericardial hemorrhage, ruptured aorta or vena cava, disruption of the thoracic duct, and cardiac contusion can all be caused by abuse. Commotio cordis, the onset of serious cardiac arrhythmia caused by a blunt impact to the chest, can be a cause of sudden death following abuse.

Abusive Fractures

Any type of fracture can be a result of abuse or accidental injury. Multiple fractures and fractures of different ages would suggest the possibility of abuse in children with normal bones and no history of major trauma.

Some types of fracture are more specific for abuse than others. "High-risk" fractures include the following.

Subperiosteal new bone formation The periosteum of the long bones of infants is somewhat loosely attached to the bone. Traction on the long bone can cause "stripping" and elevation of the periosteum leads to calcification of the tissue below the periosteum (Figure 10). Periosteal elevation can also occur in any area of increased bone metabolism. In the first 6 months of life, diffuse periosteal elevation can be seen in the absence of trauma.

Figure 10 Subperiosteal new bone formation of the tibia resulting from abuse (thicker arrow); classic metaphyseal lesions presenting as ''corner fractures'' (thin arrows).

Classic metaphyseal lesions The most vulnerable part of the developing skeleton in young children is the zone of provisional calcification in the metaphyses of the long bones. This is an area of active growth, where calcified tissue is being laid down in the primary spongiosa. Pulling, twisting, shaking, and mishandling of infants and toddlers cause typical "bucket-handle" or "corner" fractures at the metaphysis (Figures 10 and 11). These fractures actually represent planar fractures through this growing tissue.

Rib fractures Accidental rib fractures are rare in infants and young children. When abuse occurs, rib fractures are commonly found laterally and posteriorly on the ribcage. Abusive rib fractures usually result from squeezing of the chest. Anterior–posterior compression of the chest often causes the ribs to break where the rib heads articulate with the vertebrae and where the lateral curvature of the ribs occurs.

Acute rib fractures are difficult to visualize by radiographs. Alternatively, healing and the development of callus reveal infant rib fractures more easily (Figure 12). Skeletal surveys repeated 2 weeks after the initial evaluation for abuse will often yield healing fractures that were missed on the initial radiographs.

Figure 11 Classic metaphyseal lesion presenting as a ''bucket-handle fracture''.

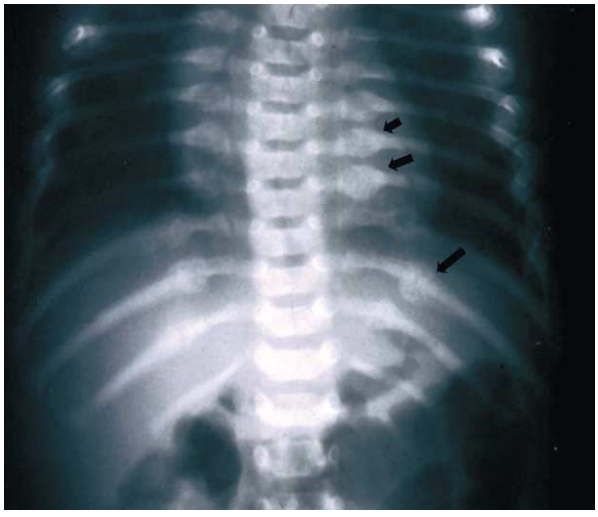

Figure 12 Multiple healing rib fractures seen on a skeletal survey (some of the many fractures are indicated by arrows).

Figure 13 Complex abusive skull fractures.

Sternal and scapular fractures Again, fractures of the sternum and scapula are rare in infants and young children, but both types of fracture can be seen associated with other types of abusive fracture to the upper arm and shoulder girdle. The acromion process of the sternum is particularly vulnerable to fracture.

Vertebral body fractures These fractures are more likely seen in children who have suffered abusive head trauma. The mechanism of injury is thought to be from hyperextension and hyperflexion of the spine during vigorous shaking, or from slamming the child down in a sitting position on to a hard surface.

Complex skull fractures Simple, linear parietal and occipital skull fractures are commonly the result of minor household trauma in infants and toddlers. The infant skull is quite plastic and in-bends readily. Complex, multiple, diastatic, or depressed fractures are less likely to occur after a simple fall and are more suggestive of abuse (Figure 13).

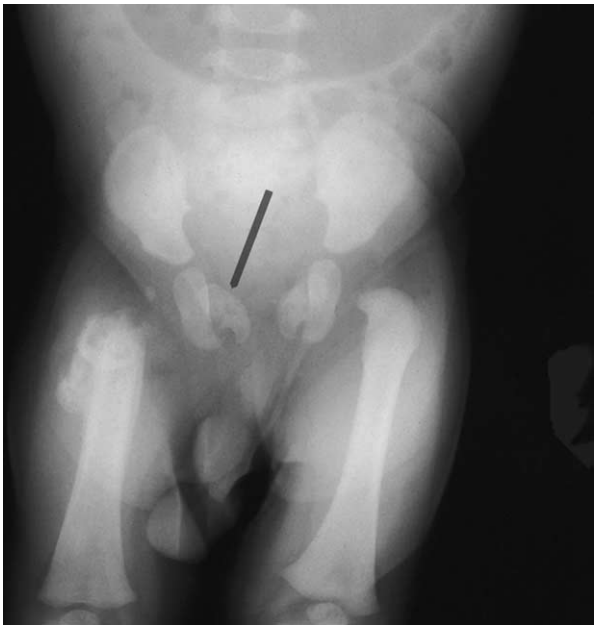

Figure 14 Pubic rami fracture (arrow) caused by abuse of an infant. Note the displaced femur fracture also present on the left.

Pelvic fracture Pelvic fractures are rare in infants and toddlers in the absence of major trauma. In abuse, fractures of the pubic rami can be seen as a result of excessive pressure on the pelvis during diapering (Figure 14).

The Multidisciplinary Evaluation of Child Abuse

Diagnosing abuse is a complex and difficult task. Cooperation between professionals in different disciplines is of great value. Physicians are often the first to suspect that a child has been abused. The physician has the unique opportunity to perform a careful study of history and physical examination. Physicians should be aware of medical conditions which are likely to mimic abuse and to be misdiagnosed as abuse. However, the physician's role is limited to the medical setting. Law enforcement officers and child protection workers are charged with the investigation of families and homes to ensure a child's safety and to determine whether or not a crime has been committed. The physician must communicate his or her findings and medical opinions to other professionals to facilitate the investigation.

Many communities have recognized the value of the multidisciplinary child protection team meeting to enhance communication between professionals. By having an opportunity to discuss complex cases, all views are aired and potential strengths and weaknesses of an investigation can be determined. It is important that physicians cooperate with other agencies to assure the safety of children.

See Also

Children: Emotional Abuse; Sexual Abuse, Overview; Sexual Abuse, Epidemiology; Non-inflicted Causes of Death; **Injury, Fatal and Nonfatal:** Documentation; Burns and Scalds

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Sexual Abuse, Overview

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Introduction

Very few areas of pediatrics have expanded so rapidly in clinical importance in recent years as that of sexual abuse of children. A risk assessment conducted for the 2002 *World Report on Violence and Health* has shown that 8% of male and 25% of female children up to age 18 experience sexual abuse of some kind. Other studies have suggested that approximately 1% of children experience some form of sexual abuse each year, resulting in the sexual victimization of 12–25% of girls and 8–10% of boys by age 18. Children may be sexually abused by family members or nonfamily members and are more frequently abused by males. Boys may be victimized nearly as often as girls, but may not be as likely to disclose the abuse. Adolescents are perpetrators in at least 20% of reported cases; only a small minority of sexual abuse allegations involve women. Emergency physicians, clinical forensic physicians, and pediatricians may encounter sexually abused children in their practices. Child abuse and neglect, sometimes also referred to as child maltreatment, are defined in the *World Report on Violence and Health*, published by the World Health Organization, as: "All forms of physical and/or emotional ill-treatment, sexual abuse, neglect or negligent treatment or commercial or other exploitation resulting in actual or potential harm to the child's health, survival, development, or dignity in the context of a relationship of responsibility, trust, or power."

Child sexual abuse is defined as the involvement of a child in sexual activity that he/she does not fully comprehend, is unable to give informed consent to, or for which the child is not developmentally prepared and cannot give consent, or that violate the laws of society.

Sexual activities encountered may include all forms of oral–genital, genital, or anal contact by or to the child, or abuse without physical contact, such as exhibitionism. Sexual activities may include the inducement or coercion of a child to engage in any unlawful sexual activity; the exploitative use of a child in prostitution or other unlawful sexual practices; and the exploitative use of children in pornographic performances and materials.

The evaluation of alleged sexual assault of a child presents the most difficult challenge to the medical professional. The role of the medical professional in assessing child sexual violation is further complicated by the frequent delay in disclosure and the very nature of child sexual abuse. Most children who report that their genitalia have been subjected to sexual contact, from touching by hand even up to full penetrative sexual intercourse, show no evidence of old or fresh injuries to the genital area. There are several reasons for this paucity of diagnostic findings. On the one hand, children are naturally reticent about reporting such conduct, so that the opportunity to see and record acute changes is lost; on the other hand, children are seldom subjected to great violence because a pedophile intent on maintaining access to a child is careful to avoid attracting attention. On those rare occasions when a child has been violently assaulted, the injuries are obvious and may require surgical repair. The history given by the child remains the bedrock of any evaluation. Knowledge of how child sexual abuse takes place and the acts involved helps doctors take better histories from carers and children and promotes understanding of the significance of genital findings.

Child sexual abuse is directly linked to further risks for the victimized child. Sexual abuse may result in other sequelae including depression, panic disorder, and attempted suicide. For all these reasons, child sexual abuse must not be neglected by any physician who may encounter such cases in his/her professional experience.

Medical examination of sexually abused children or adolescents must be undertaken in specialized centers by trained physicians. The medical examination has three aims: (1) to identify clinical evidence of genital or extragenital lesions; (2) to diagnose sexually transmitted infections or pregnancy; and (3) to evaluate the needs for medical care, psychological support, and social investigation. Laboratory investigations differ according to the delay between the abuse and the examination. Testing for human immunodeficiency virus (HIV) and hepatitis B and C virus antibodies and detection of pregnancy is realized in all cases, especially if a long delay between sexual assault and child examination is encountered. Good knowledge of child genitalia, use of magnifying lenses, training, and experience of the physician are important points of the medical intervention. Careful and precise examination allows the writing of a descriptive medical certificate, which is also a very important part of the medical intervention.

Various Circumstances of Examination of Child Victims of Sexual Abuse

Sexually abused children are seen by pediatricians and forensic physicians in a variety of circumstances:

1. children seen for a routine physical examination or for care of a medical illness, behavioral condition, or physical finding that would include child sexual abuse as part of the differential diagnosis
2. children thought to have been sexually abused and who are brought by a parent to the pediatrician for evaluation
3. children brought to the pediatrician by social service or law enforcement professionals for a medical evaluation for possible sexual abuse as part of an investigation
4. children brought to an emergency department after a suspected episode of sexual abuse for evaluation, evidence collection, and crisis management.

The presenting symptoms of sexual abuse may be so general (e.g., sleep disturbances, abdominal pain, enuresis, encopresis, or phobias) that caution must be exercised when the examiner considers sexual abuse. Nonacute genital findings indicative of sexual abuse are better examined by a physician with training in child abuse. Forensic physicians and pediatricians evaluating children who have these signs and symptoms should at least consider the possibility of abuse and, therefore, should make a report if no other diagnosis is apparent to explain the findings. For example, the French penal law, which is very strict about medical confidentiality, permits reporting of sexual abuse of children under 15 to judicial, sanitary, or social authorities. Since January 2004 reporting of sexual abuse of minors under 18 to judicial, sanitary, or social authorities has been allowed even if minors do not consent.

A complete history, including behavioral symptoms and associated signs of sexual abuse, should be sought. The primary responsibility of the physician is the protection of the child, sometimes requiring a delay in informing the parent(s) while a report is made and an expedited investigation by law enforcement and/or child protective services can be conducted.

Interviewing and Preparing the Child before a Medical Examination

In many countries, the suspicion of child sexual abuse as a possible diagnosis requires a report to both the appropriate law enforcement and child protective services agencies. All physicians need to know their state law requirements and where and when to file a written report.

The diagnosis of sexual abuse has protective and criminal consequences. The courts have allowed physicians to testify regarding specific details of the child's statements obtained in the course of taking a medical history to provide a diagnosis and treatment. Occasionally, children spontaneously describe their abuse and indicate who abused them. When asking young children about abuse, line drawings, dolls, or other aids can be used by professionals trained in interviewing young children such as in rape crisis centers and in clinical forensic units. Children may also describe their abuse during the course of the physical examination. It is desirable during the interview to use open questions and to avoid showing strong emotions such as shock or disbelief; moreover, if possible, the child should be interviewed alone.

The conversation should begin with topics which interest the child and which are nonthreatening. The evaluator should use the child's language and be reassuring. Children referred for medical examination may have been exposed to an abusive environment, or have medical or behavioral indicators of possible abuse. Children should be asked if they know why they have been brought to the doctor and to relate what has happened; what they say should be recorded in their own words. Whenever possible, the nature of the sexual contact, including pain, penetration, and ejaculation, should be ascertained, using this opportunity to give reassurance and explain the nature of the medical examination.

When children are brought for evaluation little or no history may be available other than that provided by the child. The pediatrician or clinical forensic physician should try to obtain an appropriate history in all cases before performing a medical examination. The child may spontaneously give additional information during the physical examination, particularly as the mouth, genitalia, and anus are examined.

History from the child remains a most important diagnostic feature in coming to the conclusion that a child has been sexually abused. History-taking should focus on whether the symptoms are explained by sexual abuse, physical abuse to the genital or anal area, or not. Written notes in the medical record or audiotape or videotape should be used to document the questions asked and the child's responses. Most expert interviewers consider that it is very difficult or impossible to interview children younger than 3 years.

Behavioral Indicators of Children Sexual Abuse

A behavioral history may reveal events or behaviors relevant to sexual abuse, even in the absence of a clear history of abuse in the child. The relationship of the abuser impacts on the severity of the abuse. Newly manifested behavioral changes in young child

victims of sexual abuse include: clinging behavior and irritability; loss of bowel and bladder control; thumb-sucking; withdrawal; night terrors; bedwetting; and inability to sleep alone. In school-age children, manifestations include: feeding difficulties; anorexia nervosa; overeating; change in school performance; loss of concentration; anger; and altered levels of activity with either shortened attention and hyperactivity or depression and inactivity. In preadolescents and young adolescents, behavioral changes include poor peer relationships, restricted social life, inappropriately sexualized behavior, poor self-esteem, depression, guilt, suicidal gestures, acting in a sexually inappropriate way for age, e.g. delinquency, absconding, substance abuse, and even prostitution.

Physical Examination and Medical Evaluation

The medical professional who evaluates the child who is potentially a victim of sexual abuse becomes part of an investigative team gathering information and evidence of an alleged crime. In the case of a child, the medical examiner can provide essential information about the circumstances of disclosure, behavior patterns, environmental history (where the child has been), medical history, and any past infections, interventions, or procedures that might influence the interpretation of the medical findings.

The examination should be carefully explained to the child before it is performed, in order to obtain his/her full cooperation and not to result in additional emotional trauma. It is useful to have someone present, such as a supportive adult not suspected of involvement in the abuse. Children may be anxious about giving a history, being examined, or having procedures performed. Time must be allotted to relieve the child's anxiety.

The examiner must also know that only a small proportion of all children referred for medical evaluation of sexual abuse have abnormal examinations at the time of evaluation. This may be because of the delay between facts and examination or when abuse is not so severe as vaginal or anal penetration, as occurs frequently in child sexual abuse.

If great care is taken to prepare the child it will be possible to perform an appropriate examination without sedation or anesthesia. What is to happen during the examination must be explained simply and gently to the child. Children feel better when they are allowed to choose, for example who they would like to keep with them during the examination. The experienced examiner needs to anticipate their fears and answer all questions.

The child should have a complete pediatric examination, including brief assessments of developmental, behavioral, mental, and emotional status. Special attention should be paid to the growth parameters and sexual development of the child. In the rare instance when the child is unable to cooperate and the examination must be performed because of the likelihood of trauma, infection, and/or the need to collect forensic samples, consideration should be given to using sedation with careful monitoring. Instruments that magnify and illuminate the genital and rectal areas should be used: colposcopic examination is very useful. Signs of trauma should be carefully documented by detailed diagrams, illustrating the findings, or photography. The consent for, storage of and release of such images must be strictly controlled. Specific attention should be given to the areas involved in sexual activity – the mouth, breasts, genitals, perineal region, buttocks, and anus.

Genital Examination

Appropriate positioning of the child can facilitate the examination for both child and doctor, especially to visualize the posterior portion of vaginal introitus in a young girl. In female children, the genital examination should include inspection of the medial aspects of the thighs, labia majora and minora, clitoris, urethra, periurethral tissue, hymen, hymenal opening, fossa navicularis, and posterior fourchette.

Various methods for visualizing the hymenal opening in prepubertal children have been described. Many factors will influence the size of the orifice and the exposure of the hymen and its internal structures. These include the degree of relaxation of the child, the amount of traction (gentle, moderate) on the labia majora, and the position of the child (supine, lateral, or knee-to-chest). The technique used is less important than maximizing the view and recording the method and results. Of course, speculum or digital examinations should not be performed on the prepubertal child.

Gentle labial separation and traction help to visualize the hymen within the vaginal introitus. Sterile cotton-tipped applicators can be used to delineate the hymen.

The use of colposcopy and photodocumentation has improved the detection rate for findings associated with sexual assault; they have been the basis for research into normal genital anatomy and post-traumatic changes associated with child sexual abuse in many published papers (**Figures 1** and **2**).

In the prepubertal child, vaginal penetration (past the level of the hymen) usually results in the hymen tearing between 3 and 9 o'clock. Lacerations may be associated with bruising or abrasions ventrally as well

Figure 1 Hymenal lesions.

Figure 2 Hymenal lesions.

as to the posterior fourchette and lateral introital tissues.

Anal Examination

Anal examinations can be performed in either the supine or the left lateral position; most children are less comfortable in the knee-to-chest or prone position. Anal penetration often results in lacerations, abrasions, and bruising, but examinations of any other than freshly assaulted victims may be negative (normal) in 90% of cases.

In both sexes, the anus can be examined in the supine, lateral, or knee-to-chest position. It is important to note the presence of bruises around the anus, scars, anal tears (especially those that extend into the surrounding perianal skin), and anal dilation. Anal penetration results in trauma when there has been significant force, resistance by the child, or lack of lubrication (Figures 3 and 4). However, careful penetration (finger in the young children, penis after careful lubrication in older ones) will not show any trauma, except anal dilatation in the very first times. Injuries such as bruising, abrasions, or lacerations of the anal verge will heal in a few days. Rarely,

Figure 3 Anal lesions in a preadolescent girl.

Figure 4 Anal opening in a young boy who had been frequently sexually abused.

extensive damage such as deep fissures or rupture of the sphincter will need surgical repair. Very traumatic lesions are mostly observed in sexual abuse of children associated with murder. Laxity of the sphincter, if present, should be noted. If the child reveals any events that may have occurred to the areas of the body being examined, these details should be noted.

Poor and Delayed Examination

If the alleged sexual assault has occurred within 72 h, or there is bleeding or acute injury, the examination should be performed immediately. In this situation, protocols for child sexual assault victims should be followed to secure biological trace evidence such as epithelial cells, semen, and blood, as well as to maintain a chain of evidence. When more than 72 h has passed and no acute injuries are present, an emergency examination may not be necessary, although each case must be considered on its own merits. An evaluation therefore should be scheduled at the earliest convenient time for the child, physician, and investigative team.

In children, several factors tend to lessen the chances of finding injuries diagnostic of sexual assault. Most reports of child sexual abuse note positive findings in only 43–76% of examinations. On the one hand, most children delay reporting the assault, so that many or all of the injuries disappear by healing; on the other hand, assaults upon children may be limited to fondling, simulated intercourse such as intercrural connection (penile friction between the inner thighs and external genitalia), when no injuries will ever be present.

Examination of a Male Child Victim of Sexual Abuse

In male children, the thighs, penis, and scrotum should be examined for bruises, scars, ecchymosis, and bite marks.

Photographic Documentation of the Lesions

In most major referral centers, photodocumentation has become standard practice in evaluating allegations of sexual assault. In specialized centers, examiners have mainly relied upon the use of the colposcope. This instrument has been long and widely used in sampling and screening for cancer of the cervix. In the hands of most examiners it has also been used to diagnose lesions of the external genitalia and hymen. The main value of photodocumentation of the sexual assault victim is to record the findings permanently and so avoid the need for delayed reexamination.

Forensic Sampling in Child Sexual Abuse

It is appropriate to take forensic samples if sampling is performed when the examination occurs within 72 h of acute sexual assault or sexual abuse. Some form of forensic evidence can be identified in one of four children examined within 48 h of their assault. Over 90% of children present positive forensic evidence findings when seen within 24 h of their assault. The decision to collect evidence is best made by the timing of the examination. Swabbing the child's body for evidence is unnecessary after 24 h (mouth, anus) or 48 h (skin, genitalia).

Clothing and linen yield most evidence and should be pursued vigorously for analysis. The clothing should be kept in glazed brown paper; the kind used for wrapping parcels is ideal because it is robust. The underwear should especially be kept as possible evidence. It should be checked that all areas of the clothing that are wet with secretions have dried before sealing each item in a separate evidence bag bearing an appropriately signed label.

Skin Examination

It is essential to sample, document, and process all foreign matter found on the child's body. Dried blood or secretions can be collected with saline-moistened swabs, although some laboratories prefer dry swabbing. The examination may be facilitated by appropriate ultraviolet irradiation; fluorescent material often consists of ejaculate, and the procedure helps to locate areas to be swabbed.

Oral Examination

Any trauma should be documented, if seen in a short delay. If any oral penetration has occurred, the buccal mucosa will need to be swabbed, including the areas under the tongue and around the pillars of the fauces. Swabs should be saved for microscopical examination.

Vaginal Examination

If the female child is examined shortly after the sexual abuse, the first action is to document trauma to the external genitalia and vaginal introitus. For this purpose, all secretions should be swabbed or sampled as appropriate, with great care in a nonpubertal girl. When possible, in the postpubertal victim, examination with a transparent speculum should follow to determine the degree of internal injuries. Vaginal wall and cervical injuries are common. The vaginal pool should be swabbed, once again retaining one swab for microscopic examination.

Anal Examination

In an early examination, any injuries should be documented and the perianal area swabbed, followed by the anal canal and rectum, for the presence of ejaculate and lubricants, if any; again one swab should be retained for microscopical examination. If there is any evidence of serious anorectal injury, proctoscopy may be necessary under general anesthesia.

Searching for Sexually Transmitted Diseases in Children

The predominant sexually transmitted diseases (STD) observed among children with histories or signs of abuse are syphilis, vulvovaginal candidiasis, condyloma acuminata, herpes progenitalis, and hepatitis B; very rare cases are HIV-positive.

To avoid pediatric STDs after sexual abuse, it is necessary, when not delayed, to treat promptly and adequately, in order to avoid diseases that could result in significant sequelae in children.

Gonorrhoea, syphilis, *Chlamydia*, herpes simplex and human papillomavirus, and HIV can be diagnosed by means of serology. The diagnosis of STD is important not only to the care of the victim but also in determining the fact of sexual contact. As laboratories become more sophisticated, these infections may become important forensic markers as organisms become traceable between assailant and victim. This evidence may be direct, e.g., gonorrhea, trichomoniasis, syphilis, or HIV, or confirmatory, such as *Chlamydia*. It is even possible in some cases to type individual strains of microorganisms that can also be typed on the suspected perpetrator.

Searching for STDs in abused children also means that medical professionals should provide appropriate disease prophylaxis for sexual assault victims, as well as pregnancy prophylaxis in postpubertal girls. This will vary depending on the susceptibility of organisms in different countries or local legal constraints on the use of drugs. Recent data indicate that appropriate early treatment of HIV exposure may influence the course of the infection.

All laboratory specimens must be treated carefully to protect them from contamination and degradation. The chain of evidence must be maintained using signed labels and evidence books according to local requirements. Specimens must be maintained in reliable environments before reaching the reference laboratories.

Assessing the Diagnosis of Sexual Abuse of Children

Diagnosis of child sexual abuse can often be suspected from a child's history. Its assessment is not simple. Physical findings are often absent, since many types of abuse leave no physical evidence, and mucosal injuries often heal rapidly. Occasionally, a child presents with clear evidence of anogenital trauma without an adequate history. Moreover, abused children may deny abuse. Findings that are concerning, but in isolation are not diagnostic of sexual abuse, include: (1) abrasions or bruising of the inner thighs and genitalia; (2) scarring or tears of the labia minora; and (3) enlargement of the hymenal opening. Findings that are more concerning include: (1) scarring, tears, or distortion of the hymen; (2) a decreased amount of or absent hymenal tissue; (3) scarring of the fossa navicularis; (4) injury to or scarring of the posterior fourchette; and (5) anal lacerations.

Comparison of mean hymenal diameters demonstrates that children with a history of penetration had a significantly larger transverse opening than nonabused children. Children with previous penetration are more likely than nonabused children to have a horizontal opening measuring >6.5 mm in the knee-to-chest position, and less than 1.0 mm of hymenal tissue is detected at 6 o'clock only in those with a history of penetration.

Abrasions, hematomas, and lacerations of the external genitalia heal without definitive evidence of sexual assault in a prepubertal girl. However, in cases where evidence of penetration beyond the hymen has been documented, with a resulting acute tear, the hymen will heal with clear evidence of forensic considerations. This will present as focal disruption of the hymen with loss of hymenal tissue. At puberty, all estrogen-sensitive tissue will respond, but the focal absence of hymenal tissue will persist.

Just as in the preadolescent, trauma to the external genitalia after puberty tends to heal quickly and completely. Minor lacerations and hematomas of the hymen may result in some minimal changes to the hymenal edge, which may appear similar to a redundant hymen. Major tears extending to the base of the hymen will persist and can be visualized more easily with the use of cotton-tipped swabs.

Unless the victim of anal penetration is seen within days of the assault, there will be little, if any, evidence of injury. The presence of decreased tone and fissures may be corroborative of penetration. Anal lacerations, by contrast, have rarely been found in circumstances other than those of blunt-force penetrating trauma.

In postpubertal females, the interpretation of healed trauma consistent with penetration must be made with caution. An adolescent girl who is sexually active will show hymenal injury due to consensual sexual intercourse. In cases of postpubertal vaginal assault, signs include: abrasions or hematomas; partial or complete hymenal tears; posterior fourchette injuries; lacerations; abrasions; and hematomas. Anal fissures, lacerations, and changes in anal tone may be associated with traumatic anal penetration.

The differential diagnosis of genital trauma also includes accidental injury and physical abuse. This differentiation may be difficult and may require a careful history and multidisciplinary approach. Because many malformations and infections or other causes of anal–genital abnormalities may be confused with abuse, familiarity with these other causes is important.

Physicians should be aware that child sexual abuse often occurs in the context of other family problems, including physical abuse, emotional maltreatment, substance abuse, and family violence. If these problems are suspected, referral to a child abuse specialist or assessment center for a more comprehensive evaluation is imperative.

Other Treatments Needed

It is appropriate to consider in all children who have been sexually abused that they be reviewed by a child psychiatrist to assess many factors including the need for treatment. The need for treatment varies depending on the type of sexual assault (whether the perpetrator is a family member or nonfamily member), the duration of the assault, and the age and symptoms of the child. Poor prognostic signs include more intrusive forms of abuse, more violent assaults, longer periods of sexual molestation, and closer relationship of the perpetrator to the victim.

Conclusion: Sexual Abuse and Judicial Proceedings

The evaluation of sexually abused children is increasingly a part of clinical forensic and general pediatric practice. Medical examiners are part of a multidisciplinary approach to prevent, investigate, and treat the problem and need to be competent in history-taking, physical examination, selection of laboratory tests, and differential diagnosis.

In many countries, an expanding clinical consultation network is available to assist the primary care physician with the assessment of difficult cases. Because the likelihood of criminal court action is high, detailed records, drawings, and/or photographs should be kept. The submission of written reports to justice departments is encouraged by many penal laws. Physicians required to testify in court are better prepared and may feel more comfortable in making assessments when their records are complete and accurate. In general, the ability to protect a child may often depend on the quality of the physician's records, especially in criminal court.

See Also

Children: Legal Protection and Rights of Children; Emotional Abuse; Physical Abuse; Sexual Abuse, Epidemiology

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Sexual Abuse, Epidemiology

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Introduction

Epidemiological surveys of child sexual abuse (CSA) have several objectives:

- to assess the extent of the phenomenon, through incidence, defined as the number of new cases occurring each year within a group of individuals, and prevalence, which represents the proportion of individual victims of CSA within the population
- to improve the knowledge of the various aspects of CSA, such as: risk factors, subclinical symptoms, evolution, and severity of the outcome in order to help professionals to make the earliest diagnosis and to provide the most appropriate care; it is also of interest for the judicial system to know the true impact of a crime on the victims to pronounce the most relevant sentence
- to make people aware of this public health concern.

Unfortunately, and due to the sensitive nature of this topic, the above-mentioned goals are far from being achieved.

In the first part of this article, the main and demonstrated data are presented, the second part focuses on the remaining problems that generate debate and/or may be the subject of future research.

Essential Data

There are only three methodologically sound studies about CSA epidemiology: one was conducted in the UK in 1985, and the two others were carried out in Canada and France in 1989.

These studies concern children under 16 years of age, representative of the general (nonclinical) population, and who were the victims of precisely defined sexual abuse, ranging from fondling of breasts and genital areas to more severe sexual assaults such as fellatio, masturbation, sexual intercourse, and sodomy.

Prevalence of CSA

- in both genders: 3–5%
- in females: 4–8%
- in males: 2–4%.

The age of maximum risk is 10 years, and CSA is repetitive in one-third (33%) of cases.

CSAs occur within the family in almost 20% of cases, and the perpetrator is the so-called 'functional father' (i.e., father, stepfather, or mother's partner) in 10% of cases.

The CSA is reported to judicial or health services in only 10% of cases.

In a country like France (60 million people), roughly 2 million people are victims of CSA before the age of 15 (prevalence), and the incidence is 50 000 cases each year.

A 1988 US study suggested that the incidence of CSA was around 1%, and that teenagers were the perpetrators in at least 20% of cases.

A comparison of prevalence in two French studies, one in 1989 and the other one in 2000, showed similar results for females (4.1% in 1989 versus 3.4% in 2000).

In France the legal definition of rape is restricted to sexual penetration (fellatio, vaginal intercourse, sodomy); the prevalence of this crime among females under 15 years is 300 000 in a population of 60 million, of which 50% is female.

CSA is not only a frequent and difficult judicial problem but also a major public health challenge for civilized societies; unfortunately, it is far from being controlled, as the first step of a satisfactory solution (prevention and early diagnosis) is rarely taken. This results, at least partly, from flaws found in most published epidemiological studies.

Epidemiological Studies: Flaws and Suggestions

An extensive international literature review carried out in 1994 showed large variations in prevalence and incidence ratios not linked to national specificities but rather to methodological problems such as the following.

Selection of Population

Studies based on student population, medicolegal group activities (clinical populations), or police data are not representative of the general population considering the large underreporting rate (10%).

Age Limit of Victims and Perpetrators

For legal and cultural reasons, the term "child" does not mean the same thing all over the world. With regard to the age limit of childhood, the range extends through literature from 12 to 18 years.

In the published literature, there is disagreement on the age of the perpetrator: most authors do not mention this criterion; for others, in order for the offense to be considered as an assault, the perpetrator must be an adult or at least 5 years older than his/her victim

(this would exclude consensual sexual activities between peers).

Definition of Sexual Abuse

The definition is quite broad; it includes exhibitionism, exposure to pornographic materials such as publications and movies, pinching and even the use of obscene words. As a result, in one report, although the population was well defined, the prevalence rate reached an unrealistic 51%; unfortunately, this percentage was mentioned too often in further reports. This broader definition carries the risk that these publications will not be taken seriously and may strengthen the case of those who do not want to admit the reality and the importance of CSA.

Data Collection

Fourteen of 17 publications reviewed for this article were excluded because the nonresponse rate was considered to be too high (above 50% with prevalence 5%).

The studies that had the best response rates were those in which the questions about CSA were not the primary aim of the questionnaire.

Incest

In the literature, there is no agreement on the definition of the perpetrator: for some, only the biological father could be involved; for others, all biologically linked family members could be involved, and for some, the perpetrator is the functional father, one who plays the role of the father from the victim's point of view (whether biological father, stepfather, or adoptive father). As a consequence, prevalence rates vary from 1% to 15%.

Long-Term Effects of CSA

Severity (of a crime or a disease) is a concept accepted by both the judicial and the health systems; accordingly, harshness on the part of law enforcement depends at least in part on the negative clinical effects of CSA on the victims. Therefore, in most countries sentences are more or less in proportion to the clinical type and supposed gravity of CSA, e.g., rape is more severely punished than fondling, and incest between a father and his daughter is more severely punished than the same sexual assault committed by an unknown assailant.

This rationale is backed by many physicians who consider that a history of CSA will increase the risks of mental disorders such as depression and suicide, and of becoming an abusive parent. However, these hypotheses have not yet been scientifically demonstrated; they are based on retrospective studies evaluating the number of CSA cases in clinical groups (prostitutes or psychiatric patients generally), but not on prospective studies. Only the previously mentioned UK study provided limited information of this kind, showing that responders and nonresponders, CSA victims and nonvictims, did not differ with respect to either social professional groups or geographic location at the time of the study.

Of course, there is no question that some types of CSA will have short-term, mid-term, and long-term severe adverse effects (clinical, social, and judicial), but basing judicial policies on highly hypothetical medical beliefs might also be regarded as an abuse.

Historical Evolution of CSA

Due to the dramatic increase in cases reported to police, especially in the early 1990s in countries where information campaigns were undertaken, one might think that there is a real increase in CSA cases. However, the only study designed to answer this question did not show any difference in prevalence rates among victims aged between 15 and 65 years (the low rate found in victims aged over 65 at the time of the study might be due to the victims' memory problems).

Thus, it seems that the increase in cases is due to an improvement in reporting rates. There are great prospects for further improvement, considering that CSA is still the tip of an iceberg, with 90% of its mass underwater.

Physicians' Role

Unfortunately, physicians play a minor role. Various studies in France and the USA have shown that they played an active role in fewer than 10% of CSA cases reported to authorities. Another French study showed that they were not intentionally underreporting (for reasons of confidentiality, for instance): they are just unable to detect CSA in patients who consult for other reasons.

In Finistère (Brittany, France), a survey showed that all physicians in this area (general practitioners and specialists) diagnosed only 15% of the CSA which occurred during the year 1993.

Conclusion

The epidemiological studies about CSA provide us with some clear facts:

- the victims are twice as likely to be female as male
- the age at which children are most at risk is 10 years
- the aggressor is often known by the victim and there is a high rate of relapse if nothing is done to stop the abuse
- unfortunately, the low rate of reporting to authorities (10%) shows that all too often, nothing is done.

These studies also provide a long list of features, among which ignorance of early symptoms (medical, psychological, or social) should be stressed, which lead to poor diagnostic conclusions and the unknown severity of the effects of each type of CSA. This results in a lack of evaluation of the appropriate care that should be provided for this large public health problem.

Indeed, further studies are needed. However, it is important to mention that they are difficult to realize, expensive, and often limited by ethical considerations.

CSA is one of the least tolerable crimes in public opinion. Building a CSA-free world should make it a priority to undertake an international effort to fight this outrage – this should begin with properly designed longitudinal and collaborative epidemiological studies based on consensual definitions of all the variables to be evaluated.

See Also

Children: Sexual Abuse, Overview; **Imaging:** Radiology, Pediatric, Scintigraphy and Child Abuse

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Sudden Natural Infant and Childhood Death

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Introduction

Sudden death in infancy and childhood has many natural, inflicted, and noninflicted causes. This article concentrates on the wide range of natural diseases that may result in sudden and unexpected deaths of previously well, or medically stable, infants and children. Deaths due to inflicted and noninflicted injuries are dealt with elsewhere, and, due to its unique position, characteristic and postulated mechanisms for sudden infant death syndrome (SIDS) are dealt with in detail separately.

Accuracy of diagnosis is of prime importance in cases of unexpected infant and childhood death in order to understand underlying mechanisms, optimize outcomes for grieving families, enable future pregnancy counseling, and ensure that data and information supplied for vital statistics are correct.

Determining the incidence of sudden childhood death is not necessarily an easy task as rates vary among populations and within communities over time. Death certificate and autopsy diagnoses may not always be correct, as there is often regional bias in preferred diagnoses, and investigations may not always be comprehensive or follow standard protocols. Rates for sudden natural death have varied between 1.1 and 13.8 cases per 100 000 of the pediatric population, accounting for 2–5% of deaths in the age range of 1–20 years. The most common causes of sudden natural death also vary according to age. For example, lethal infections tend to occur at a younger age than cardiac abnormalities. Infections are more often lethal in nonwestern countries. Causes of sudden natural childhood death are summarized in **Table 1**. Only selected conditions have been discussed in the following article. Further details of these and other conditions are available in standard texts.

Sudden Infant Death Syndrome

SIDS, or crib death or cot death, is defined as "the sudden death of an infant less than one year of age which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history." Despite dramatic falls in rates following "reduce the risk" campaigns characterized by changes in infant care practices, SIDS remains the most common cause of postneonatal death in western countries.

The term SIDS can only be applied after other causes of unexpected infant death such as accidents, inflicted injury, and natural diseases have been excluded. If investigations and autopsies are not meticulously performed there is, therefore, a danger that other causes of death may be incorrectly termed SIDS. This possibility led the late John Emery to warn against using SIDS as a "diagnostic dustbin." The following article details a range of conditions that may be confused with SIDS. An important concept that cannot be overemphasized is that "not every infant who dies in a crib dies of crib death."

The characteristic features and possible causes of SIDS deaths are summarized elsewhere.

Table 1 Differential diagnosis of unexpected infant and childhood death due to natural diseases

Idiopathic
Sudden infant death syndrome

Cardiac
Congenital cardiac defects (before and after surgery)
Cardiomyopathies
Tumors
Conduction defects
Infections
Miscellaneous: endocardial fibroelastosis

Vascular
Aortic abnormalities: supravalvular stenosis, coarctation, William syndrome, DiGeorge syndrome
Coronary artery abnormalities: anomalous coronary arteries, aplasia/hypoplasia, idiopathic arterial calcinosis, coronary arteritis (Kawasaki disease)
Venous abnormalities: total anomalous pulmonary venous drainage
Vascular malformations
Pulmonary hypertension
Miscellaneous: fibromuscular dysplasia, thromboembolism

Infectious
Cardiovascular: myocarditis
Respiratory: acute bronchopneumonia
Central nervous system: meningitis, encephalitis
Gastrointestinal: gastroenteritis, botulism
Genitourinary: pyelonephritis
Generalized: septicemia, endotoxemia

Respiratory
Asthma
Upper-airway obstruction
Bronchopulmonary dysplasia
Infections
Miscellaneous: massive pulmonary hemorrhage, tension pneumothorax

Central nervous system
Hemorrhage: bleeding diathesis, vascular malformations
Tumors
Epilepsy
Metabolic disorders
Infections
Miscellaneous: tuberous sclerosis

Hematological
Hemoglobinopathies: sickle-cell disease
Malignancies: lymphoma, leukemia
Bleeding diathesis
Anemia
Miscellaneous: infections, polycythemia, splenic disorders

Gastrointestinal
Intestinal obstruction: intussusception, volvulus
Intestinal perforation
Late-presenting congenital diaphragmatic hernia
Gastroesophageal reflux/aspiration
Infections: gastroenteritis
Miscellaneous: cystic fibrosis, malnutrition

Genitourinary
Wilms tumour
Hemolytic–uremic syndrome
Complications of pregnancy
Primary renal disease: pyelonephritis, glomerulonephritis
Urinary tract obstruction

Metabolic
Fatty acid oxidation defects: acyl-coenzyme dehydrogenase deficiencies (medium-chain, long-chain)
Reye's syndrome
Carbohydrate disorders: glycogen storage diseases
Organic acid disorders

Endocrine
Insulin-dependent diabetes mellitus
Congenital adrenal hypo/hyperplasia

Miscellaneous
Connective tissue disorders: Marfan syndrome, Ehlers–Danlos syndrome type IV
Skeletal disorders: achondroplasia
Chromosomal disorders: trisomy 21

Adapted from Byard RW (2004) *Sudden Death in Infancy Childhood and Adolescence*, 2nd edn. Cambridge: Cambridge University Press.

Cardiac Conditions

A multitude of structural, infectious, cardiomyopathic, and neoplastic cardiovascular disorders may cause sudden infant and childhood death.

Congenital Defects

Congenital defects include cyanotic, acyanotic, and obstructive conditions, the two most common being tetralogy of Fallot and transposition of the great vessels. Complications resulting in sudden death include rhythm disturbances and cerebral or myocardial infarction associated with polycythemia. Even after successful surgical repair, there remains a significant risk of sudden death due to heart block and arrhythmias.

Ventricular septal defects are the most common congenital heart defect, but rarely cause sudden death. In clinically significant cases affected infants and children usually manifest signs of cardiac failure, with failure to thrive, feeding difficulties, and sweating. Uncomplicated atrial septal defects are not a cause of sudden death in infancy or early childhood.

Cardiomyopathies

Cardiomyopathies represent a heterogeneous group with variable inheritance patterns. A number of familial metabolic disturbances are also characterized by secondary cardiomyopathies. Hypertrophic cardiomyopathy is characterized by a marked increase in the size and weight of the heart. Inheritance may be autosomal dominant or recessive, involving gene defects in at least eight chromosomes with disruption in coding for contractile proteins actin and myosin. Typical pathological features include marked reduction in the size of the left ventricular cavity with typical myofiber disarray on light microscopy.

Other cardiomyopathies associated with unexpected death are dilated and restrictive, and both have heterogeneous etiologies. Arrhythmogenic right ventricular cardiomyopathy (Figure 1) refers to a specific familial condition that primarily affects the right ventricle with fibrolipomatous replacement of muscle tissue. Rarer entities that may cause unexpected infant death include histiocytoid cardiomyopathy (Figure 2) and noncompaction of the left ventricle. Endocardial fibroelastosis associated with structural abnormalities or metabolic conditions may also be associated with sudden death (Figure 3).

Outflow Obstruction

Any lesion that causes obstruction to the outflow of blood from the left ventricle may result in cardiac hypertrophy with its attendant risk of lethal arrhythmia. Examples include coarctation or disruption of

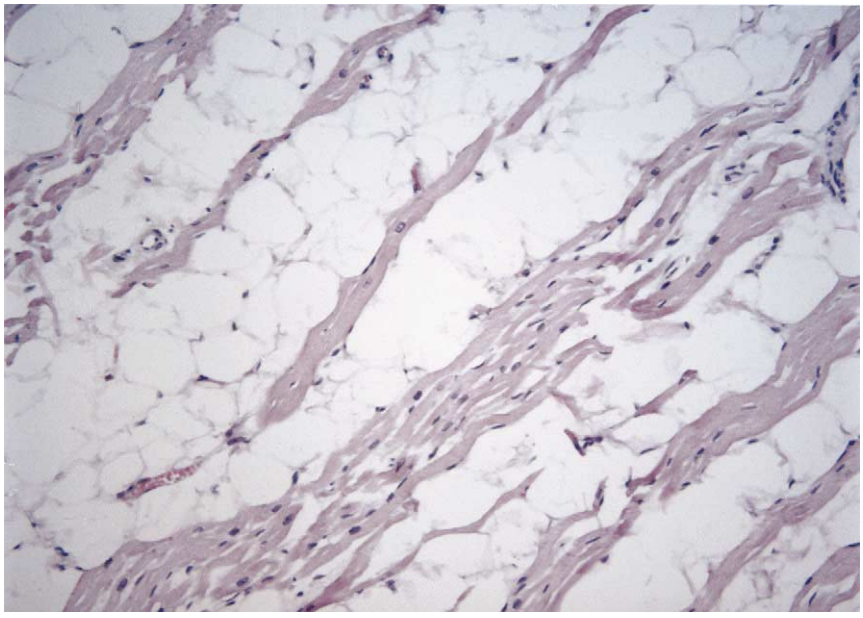

Figure 1 A case of sudden death of a young child caused by arrhythmogenic right ventricular cardiomyopathy with fat replacing right ventricular myocardium. Hematoxylin & eosin, 200×.

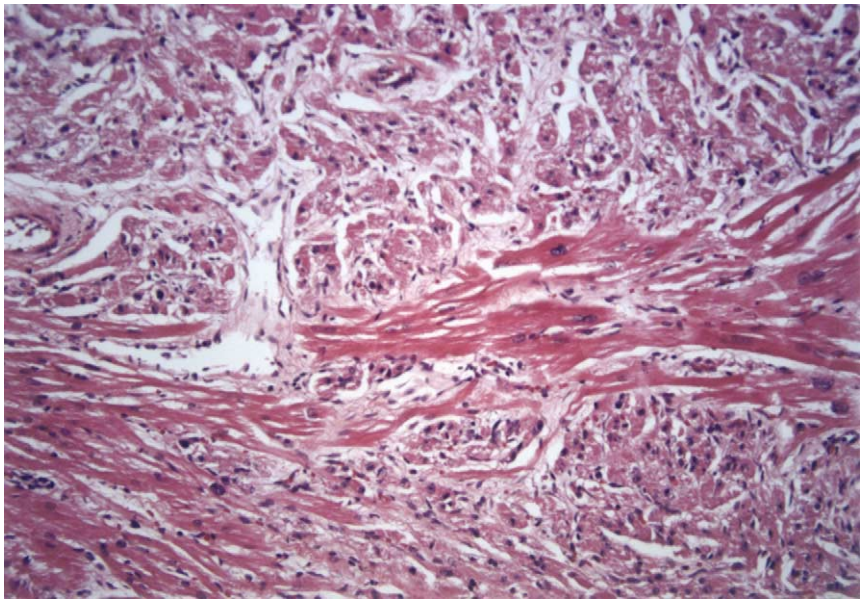

Figure 2 Islands of altered myocytes with eosinophilic granular cytoplasm (upper and lower fields) replace normal myocardium (center) of the heart of an infant with histiocytoid cardiomyopathy who died suddenly and unexpectedly. Hematoxylin & eosin, 200×.

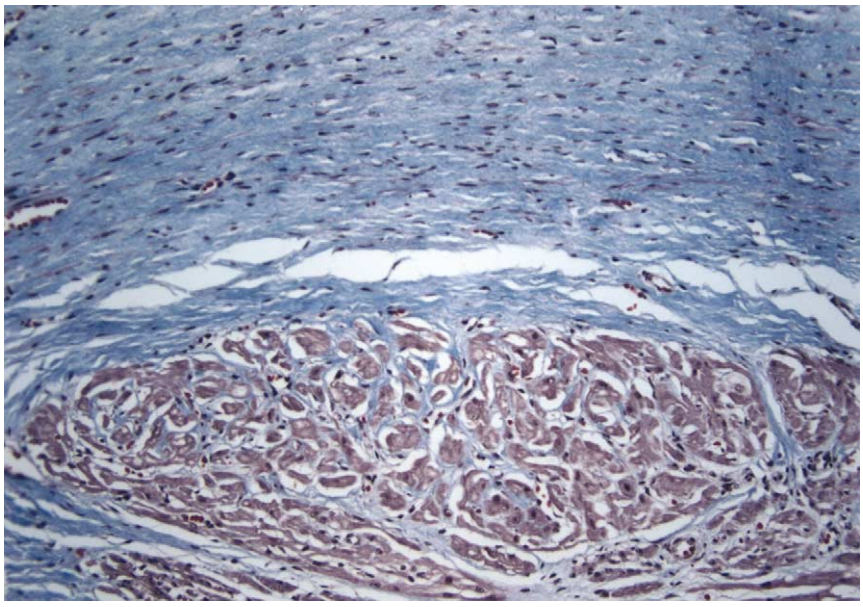

Figure 3 Endocardial fibroelastosis of left ventricle showing marked thickening with fibrous and elastic tissue. Masson trichrome, 200×.

the aortic arch and stenosis of the aortic valve, which may be unicuspid or bicuspid. Subaortic stenosis caused by either a fibromuscular membrane or diffuse narrowing of the outflow tract is another cause of sudden death in infancy or childhood.

Tumors

Tumors such as rhabdomyomas, fibromas, or myxomas may occur within the heart in infants and young children and cause significant problems from outflow tract obstruction, embolization, or conduction tract disruption. Rhabdomyomas may be a "forme fruste" of tuberous sclerosis, a condition characterized by mental retardation, epilepsy, and an increased risk of sudden death.

Conduction Tract Disorders

Conduction tract problems may also arise with a variety of other conditions and include entities such as the prolonged QT interval syndromes. Disturbances in genes controlling cardiac sodium and potassium channels result in prolongation of the QT interval and have significant association with sudden death. Swimming may be a trigger to a lethal arrhythmia in children with long QT syndrome (LQTS) and in infancy there has been confusion with SIDS. More than 35 LQTS gene mutations have now been identified in LQTS. The diagnosis can be established by epinephrine (adrenaline) challenge of a decedent's mother, or by analysis of the decedent's blood or paraffin-embedded cardiac tissue using exon-specific amplification by polymerase chain reaction and direct DNA sequencing to identify the various gene mutations.

Vascular Conditions

Again there are a wide range of disorders that may cause sudden childhood death.

Aortic Abnormalities

Outflow obstruction, as with cardiac conditions described above, may cause significant cardiac hypertrophy with an increased risk of lethal arrhythmia. Supravalvular stenosis, due to an autosomal dominantly inherited disorder of elastin, has several forms, including membranous, tubular, and hourglass narrowing of the aorta distal to the aortic valve. Coarctation due to a discrete narrowing near the ligamentum arteriosum has a similar effect.

Williams syndrome is due to a mutation or deletion on chromosome 7q11.23 and is characterized by infantile hypercalcemia, abnormal facies, peripheral pulmonary artery stenosis, supravalvular aortic stenosis, and growth and developmental retardation. Sudden death results from the effects of coronary artery stenosis or ventricular outflow tract obstruction.

DiGeorge syndrome results from a microdeletion of chromosome 22q11.2 causing abnormalities of tissues derived from the third and fourth pharyngeal pouches. Affected children have characteristic dysmorphic facies and suffer from thymic and parathyroid aplasia or hypoplasia, with aortic arch anomalies, truncus arteriosus, or tetralogy of Fallot.

Coronary Artery Anomalies

The coronary arteries must be evaluated for the positions of their ostia, as well as variations in the angles

of their take-off from the aorta, and initial and subsequent courses. Ostial ridges or membranes may also result in significant compromise of blood flow. Coronary artery anomalies may be part of complex congenital malformations of the heart or an isolated defect, and are a well-recognized but rare cause of sudden death in infancy and childhood.

Anomalous coronary arteries may arise from the opposite sinus of Valsalva, the aortic arch, the opposite coronary artery, or the pulmonary trunk. Sudden death has occurred with all variants when there is sufficient angulation or luminal narrowing to compromise blood flow.

Idiopathic arterial calcinosis is a rare disorder characterized by calcification of arterial walls. Lethal consequences result from coronary artery narrowing.

Kawasaki disease, or mucocutaneous lymph node syndrome, is now the major cause of acquired heart disease in children in western countries. The etiology is uncertain; however, it is characterized by transmural coronary arteritis with medial degeneration, thrombosis, and aneurysmal dilatation.

Venous Abnormalities

Total anomalous pulmonary venous connection (TAPVC) occurs when there is drainage of pulmonary veins into the systemic venous system rather than into the left atrium. Drainage may be above or below the diaphragm. Significant obstruction of the common draining vein may be associated with the development of pulmonary hypertension.

Other vascular disorders associated with sudden infant and childhood death include vascular malformations, other causes of pulmonary hypertension, and arterial fibromuscular dysplasia. Fatal pulmonary thromboembolism may also rarely occur in infancy and childhood associated with similar predisposing conditions to adults such as immobilization, recent surgery, venous stasis, sepsis, and malignancy.

Infectious Disorders

Fulminant infections of the heart, lungs, and/or central nervous system can cause rapid deterioration and sudden death, even in infants and children who have not appeared particularly unwell prior to collapse.

Myocarditis

Inflammation of the heart may be caused by a variety of infectious and noninfectious agents. Viral infection is most likely due to coxsackie B viruses but may also occur with coxsackie A, echo, polio, cytomegalo, human immunodeficiency, parvo, influenza, and adeno viruses. Although infants and children may present with a febrile illness and/or cardiac failure a significant percentage may have minimal or no symptoms prior to their terminal collapse. At autopsy, variable degrees of inflammation, edema, and fibrosis with myocyte necrosis (Figure 4) will be found. A giant-cell variant also occurs. Sudden death is caused by lethal arrhythmias.

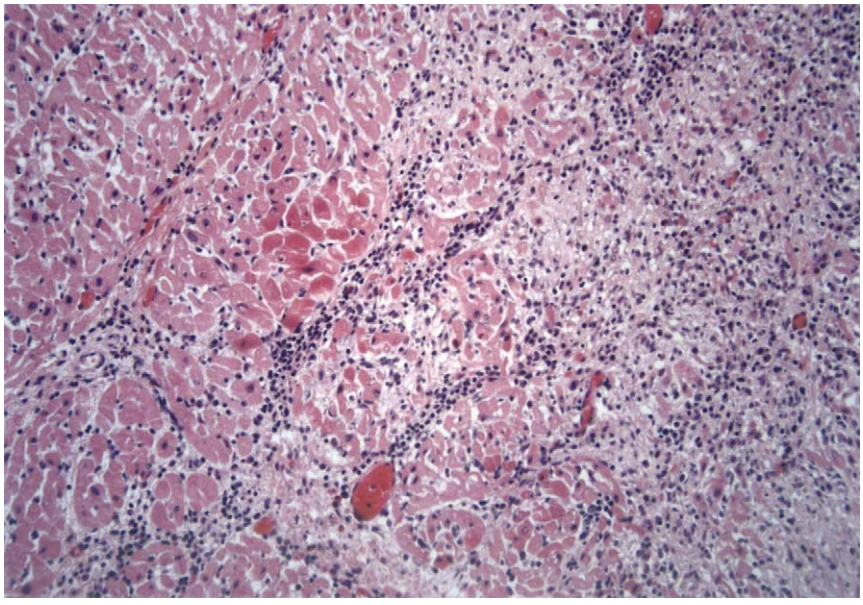

Figure 4 Myocarditis characterized by lymphocytic infiltration and myocardial necrosis with interstitial edema and fibrosis that caused the sudden death of an infant. Hematoxylin & eosin, 200×.

Rheumatic Fever

The incidence of rheumatic fever has declined markedly in western communities. It follows a group A streptococcal infection and causes, amongst other lesions, inflammatory foci within the heart and valves, with vegetation formation. Sudden death results from myocarditis with arrhythmias, or from embolization of friable valvular vegetations into the coronary arteries.

Upper Respiratory Infections

Acute inflammation from infection around the upper aerodigestive passages may result in sudden death if there is compromise of airway patency. The classic example is acute epiglottitis where infection with *Haemophilus influenzae* type B causes swelling of the epiglottis with obstruction of the inlet to the larynx. Cases are rare now that immunization for *Haemophilus* has been undertaken.

Acute bacterial infection of the tonsils, posterior portion of the tongue, or retropharyngeal spaces may also cause lethal airway occlusion, as may infections of the trachea. Pseudomembranes in diphtheria, and less often in bacterial tracheitis, may dislodge and obstruct upper airways.

Lower Respiratory Infections

Acute bacterial pneumonia (Figure 5) may be fulminant, especially with organisms such as *Streptococcus pneumoniae*, *H. influenzae*, and *Staphylococcus aureus*. In established cases there will be filling of alveoli and distal airways with neutrophils with early organization. Lung and blood cultures are required in the autopsy assessment.

Meningitis

Bacterial infection of the cerebrospinal fluid and the meninges may cause a rapidly progressive clinical disorder resulting in death. This is particularly so with meningitis due to *Neisseria meningitidis*. Other pathogens that cause meningitis in infants and children include *H. influenzae* and *Streptococcus pneumoniae*. These latter organisms are now uncommon given the widespread administration of immunizations during infancy and early childhood.

The clinical presentation may be nonspecific in infants, compared to older children, who may complain of photophobia and nausea. Autopsy findings may not necessarily include characteristic acute inflammation of the meninges, as death may result from endotoxemia before overt acute inflammation becomes established. Brain swelling with vessel thrombosis and/or infarction may occur and bilateral intraadrenal hemorrhage, Waterhouse–Friderichsen syndrome, may be present.

Gastroenteritis

Globally, gastroenteritis is one of the major causes of infant and early childhood death. Dehydration and electrolyte imbalances may result in fatal outcomes. At autopsy typical features of dehydration include sunken eyes, sunken fontanelle, wrinkling of

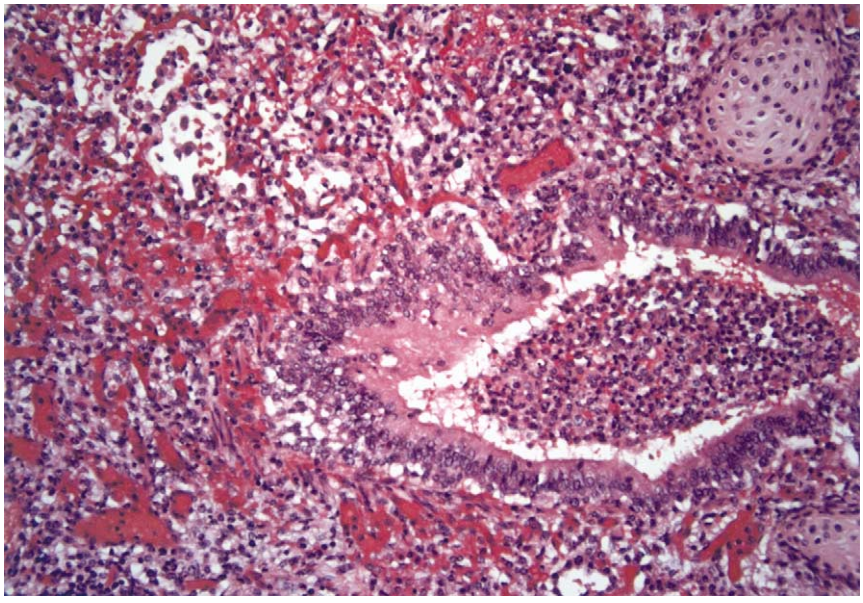

Figure 5 A section of lung from an infant who died unexpectedly from bronchopneumonia showing neutrophils infiltrating a distal bronchus (right) and adjacent alveoli. Vascular congestion and intraalveolar hemorrhage are also present. Hematoxylin & eosin, 200×.

the liver capsule, and drying of mucosal and serosal surfaces. Vitreous humor analyses will show sodium levels of greater than 155 mmol l^{-1}. Hyperkalemic cardiac arrhythmias may cause sudden death, as may central nervous system venous thromboses. Neglect or deliberate withholding of water must be considered.

Respiratory Conditions

Acute upper-airway obstruction by foreign material such as food (Figure 6) or a toy part is not uncommon in infants and young children. Other respiratory causes of sudden death in children are less frequent.

Asthma

Although acute asthma may cause sudden death in the pediatric age range it usually involves older children who have either a history or autopsy findings of significant disease. Death may be due to asphyxia, cardiac arrhythmia, or electrolyte disturbance. Anti-asthma drugs have been implicated in some cases and full toxicological screening is required. At autopsy there is usually hyperinflation of the lungs with mucus plugging of airways. There may be a pneumothorax or changes of alveolar overdistension.

Upper-Airway Obstruction

Apart from airway blockage from foreign materials, there are a range of natural disorders that may encroach upon the upper aerodigestive tract producing critical narrowing. These include choanal atresia, lingual thyroglossal duct cysts, nasopharyngeal tumors, heterotopic tissues, vascular malformations, and upper-airway infections. Micrognathia in conditions such as Pierre–Robin syndrome may cause a retro-positioned tongue to occlude the airway, as may macroglossia. Structural defects such as laryngo- and tracheomalacia may also narrow the airway, as may upper-airway infections.

Bronchopulmonary Dysplasia

This chronic lung disease develops in infants after a period of prolonged assisted ventilation. It is characterized by scarring of lung parenchyma with obliteration of alveolar spaces. Pulmonary hypertension, ventilation–perfusion mismatch, bronchial hyperreactivity, and reduced lung compliance may all be associated with an increased risk of sudden death.

Neurological Conditions

Conditions that interfere with neural control of respiration and cardiac function may cause sudden death. Due to the unique characteristics of the skull, space-occupying lesions in the form of tumors or hemorrhage may not only compromise cerebral function by destroying tissue, but may also cause elevation of intracranial pressure. This compresses vital centers and interferes with blood flow and oxygenation.

Hematological Disorders

Any conditions that predispose to spontaneous hemorrhage, such as hemophilia or thrombocytopenia,

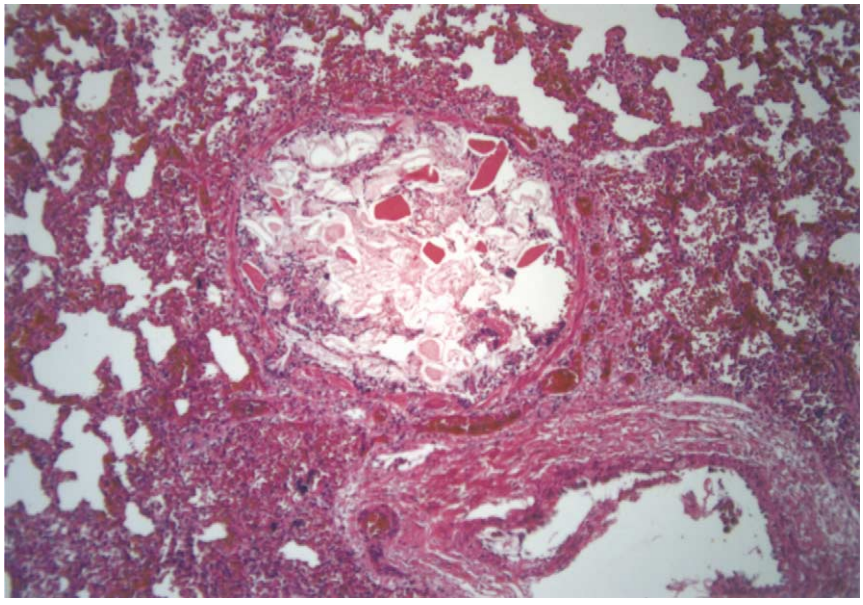

Figure 6 A case of fatal aspiration in a young child with occlusion of a bronchiole by gastric contents including meat fibers. Hematoxylin & eosin, 200×.

may be associated with lethal intracranial hemorrhage. Similarly, hematological conditions with a tendency to spontaneous thrombosis such as deficiencies in plasminogen, antithrombin III, and proteins S and C, may cause ischemic stroke in children. This may also occur with the hemoglobinopathies.

Vascular Disorders

Vascular malformations or aneurysms may cause death due to spontaneous hemorrhage from weakened vessel walls. Both vascular malformations and aneurysms may be solitary or associated with more generalized conditions, including Osler–Weber–Rendu syndrome (hereditary hemorrhagic telangiectasia), cystic renal and liver disease, and connective tissue disorders.

Tumors

Tumors located at critical sites in the brain may cause death due to compression of brainstem autonomic control centers or to acute hydrocephalus from obstruction to cerebrospinal fluid drainage. Presenting symptoms may be entirely nonspecific and treatment for a presumed viral gastroenteritis may have been mistakenly initiated in the preceding days. Even quite slow-growing tumors within the cranial cavity may precipitate clinical deterioration if there is hemorrhage into the tumor or into adjacent cerebral tissue.

Epilepsy

While it is recognized that there is an increased risk of sudden death in epileptic children, underlying mechanisms are far from clear. Certainly there is a risk of traumatic death such as drowning in children with epilepsy, or to death from an underlying syndrome such as tuberous sclerosis. However, other children may be found dead with minimal findings. Suffocation, respiratory arrest, and/or cardiac arrhythmias are likely mechanisms in fatal cases. Autopsy examinations should include neuropathological evaluation of the brain, looking for underlying abnormalities that may have been responsible for the epileptic discharges, or for evidence of chronic hypoxic–ischemic damage due to previous fitting.

Metabolic Disorders

Familial or acquired metabolic disorders may be associated with thromboembolism and ischemic stroke (e.g., homocystinuria), or hemorrhage (e.g., scurvy).

Structural Abnormalities

Children with Arnold–Chiari malformation, in which there is downward displacement of the medulla and cerebellum into the cervical spinal canal, are at risk of sudden death due to a variety of problems. Brainstem compression may cause respiratory arrest and recurrent laryngeal nerve paralysis may result in laryngeal obstruction. Shunts inserted for hydrocephalus may block, or cause lethal thromboembolism, pulmonary hypertension, or ascending infection.

Miscellaneous Disorders

Unexpected death has also occurred in children with a wide range of disorders that affect the central nervous system including Friedreich's ataxia, tuberous sclerosis, von Recklinghausen disease, septo-optic dysplasia, Guillain-Barré syndrome, and Déjérine–Sottas disease.

Hematological Conditions

Hemoglobinopathies

The most significant hemoglobinopathy is sickle-cell disease due to replacement of glutamic acid by valine in the sixth position on the β-chain of the hemoglobin molecule. Reduced plasticity of red blood cells results in a sickled shape with blood vessel obstruction. Sequestration crisis occurs when sickled red cells become trapped within the spleen, causing circulatory collapse. Homozygous children are also at risk of sudden death due to overwhelming sepsis.

Hematological Malignancies

Acute leukemias may present as sudden death due to intracerebral hemorrhage from primary or secondary thrombocytopenia. Mediastinal lymphomas have been associated with external compression of the upper airway with lethal obstruction.

Disorders of Coagulation

Inherited or acquired defects in coagulation pathways may result in life-threatening hemorrhage, particularly if bleeding occurs inside the skull. Accidental and inflicted injuries must be considered in cases of intracranial hemorrhage given they are far more common than disorders of coagulation.

Gastrointestinal Conditions

Intestinal Obstruction

Intussusception and volvulus are causes of potentially lethal intestinal obstruction in children. Although the usual presentation involves abdominal pain and vomiting, occasional cases are clinically silent, resulting in serious electrolyte disturbances and dehydration with established sepsis occurring before a

diagnosis is made. These cases may, therefore, not be identified until autopsy. Predisposing lesions such as hyperplastic Peyer patches or Meckel diverticulum in cases of intussusception and cystic fibrosis in cases of volvulus should be looked for.

Gastric Dilatation and Perforation

Marked gastric dilatation with fatal perforation may occur in children with cerebral palsy due to air swallowing and autonomic neuropathy, in children with eating disorders, and in children with Prader–Willi syndrome. In the latter instance excessive appetite with decreased vomiting and a high pain threshold predispose to gastric rupture.

Late-Presenting Diaphragmatic Hernias

Small defects in the diaphragm may not be associated with intrauterine herniation of abdominal organs into the pleural cavity. As a result, defects may be plugged by the spleen or liver until much later in life. When herniation occurs there may be sudden death from mediastinal shift with compression of the heart and lungs. Occasional cases survive for some time with nonspecific symptoms until gastric or intestinal perforation occurs into the pleural space. Cases have presented in a similar manner to SIDS.

Genitourinary Conditions

Although diseases of the renal system are not usually associated with sudden death, certain conditions may have catastrophic outcomes.

Wilms Tumor

Wilms tumor, or nephroblastoma (Figure 7), is a primary malignancy of the kidneys that occurs mainly in childhood and is now associated with a good prognosis. Occasional cases may, however, present with sudden death, for example, if there has been extensive hemorrhage into tumor parenchyma, or if a portion of this angioinvasive tumor extends into or embolizes to the lungs.

Hemolytic–Uremic Syndrome

This systemic thrombotic microangiopathy is characterized by thrombocytopenia, hemolytic anemia, and renal insufficiency. It often follows infection with vero-toxin producing *Escherichia coli* and may cause sudden death from intracerebral hemorrhage.

Complications of Pregnancy

Pregnancy should be excluded as a possible cause of sudden death in any sexually mature female adolescent. Conditions such as amniotic fluid embolism, ruptured ectopic pregnancy, placental hemorrhage, peripartum cardiomyopathy, or vascular rupture should be checked for at autopsy.

Metabolic Conditions

More than 30 metabolic disorders that may cause illness and death in infancy and childhood can now be detected by tandem mass spectrometry, which is indicated in essentially all cases of unexplained infant and childhood death. Even though they are rare, their

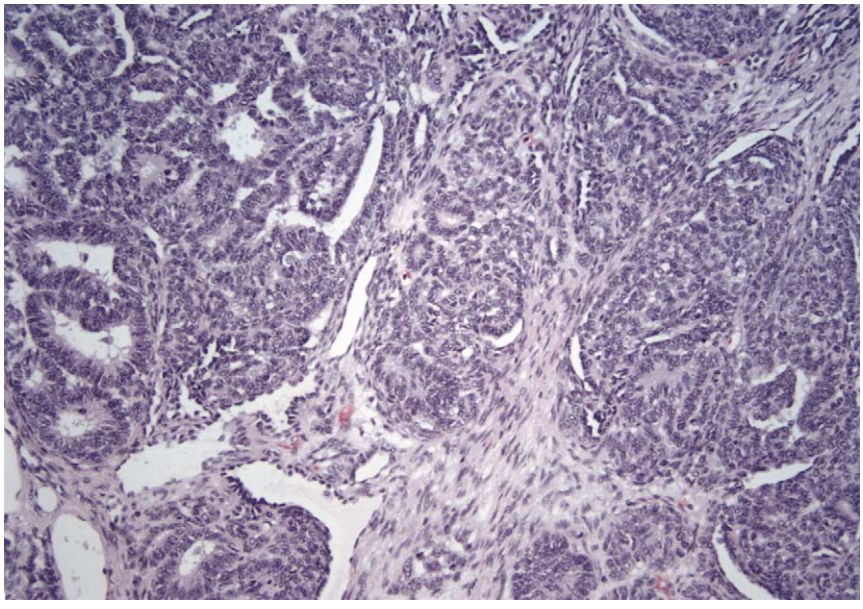

Figure 7 Wilms tumor characterized by epithelial, blastemal, and ill-defined mesenchymal differentiation. Hematoxylin & eosin, 200×.

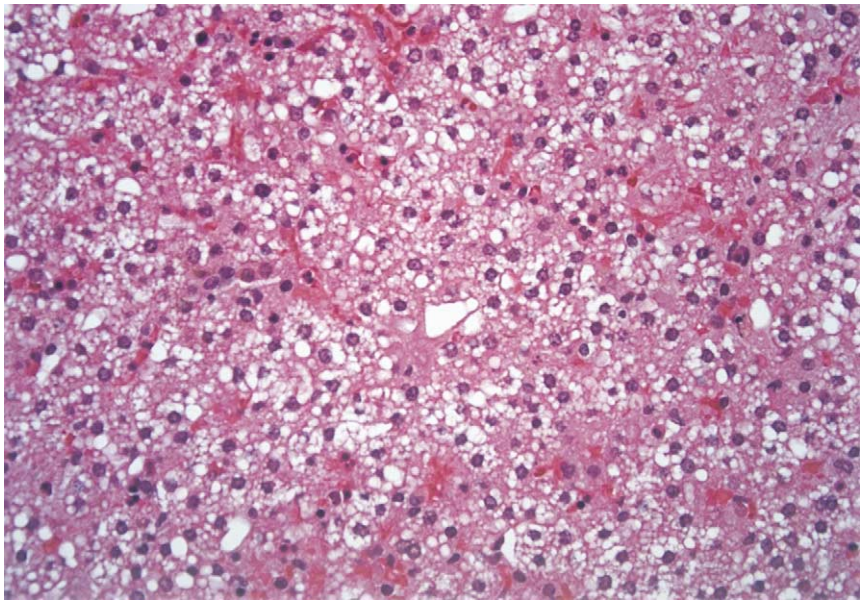

Figure 8 A section of liver from a neonate who died suddenly at 3 days of age with very-long-chain acyl-coenzyme A dehydrogenase deficiency revealing diffuse microvesicular fatty change. Hematoxylin & eosin, 200×.

diagnosis is critical in not only explaining death, but also in future pregnancy planning. Although amino acid and organic acid disorders are usually characterized by obvious illness and deterioration, fatty acid disorders such as medium-chain acyl-coenzyme A dehydrogenase deficiency (MCAD), long-chain acyl-coenzyme A dehydrogenase deficiency (LCAD), and very-long-chain acyl-coenzyme A dehydrogenase deficiency (VCLAD) (Figure 8), long-chain L-3-hydroxy acyl-coenzyme A dehydrogenase deficiency (LCHAD), and carnitine palmitoyltransferase deficiency type II (CPT II) may have subtle courses before sudden death occurs.

Endocrine Conditions

Insulin-Dependent Diabetes Mellitus

Sudden death may occur in affected children from ketoacidosis, or from excessive insulin administration. There is also a group of young diabetics who have been found dead in bed for no obvious reason. Nocturnal hypoglycemia may be the cause of death in these cases.

Adrenal Hypo- and Hyperplasia

Congenital hypoplasia of the adrenal gland may be associated with an Addisonian crisis and death. Conversely, hyperplasia of the adrenal glands, due to enzymatic defects in the cortisol synthetic pathway, may lead to excessive sodium loss and collapse.

Miscellaneous Conditions

A variety of other rare and unusual conditions may be found at autopsy in cases of sudden and unexpected infant and childhood death. These include connective tissue disorders such as Ehlers–Danlos and Marfan syndromes; skeletal disorders such as achondroplasia; dermatological disorders such as hypohidrotic ectodermal dysplasia; muscular disorders such as malignant hyperthermia; chromosomal disorders such as trisomy 21 and fragile X syndrome; and immunological conditions such as anaphylaxis and myasthenia gravis.

Conclusions

While SIDS remains the most common cause of postneonatal sudden unexpected infant death, a wide range of other conditions may cause sudden and unexpected death in infancy and early childhood. Accurate delineation of the cause and manner of death is dependent upon meticulous review of the medical history, careful examination of the death scene, and thorough postmortem examination. Scene reconstruction may be especially illuminating in understanding potential mechanisms of death in cases of noninflicted injury. Ancillary studies, including tandem mass spectroscopy screening for metabolic disorders and measurement of vitreous electrolytes, are also critically important in the evaluation of cases in which the cause of death is not immediately

apparent. Unfortunately, unless autopsy examinations are scrupulously undertaken, many of the cases of subtle natural disease described above will remain undiagnosed or misdiagnosed.

See Also

Children: Physical Abuse; Non-inflicted Causes of Death; **Sudden Infant Death Syndrome, Etiology and Epidemiology**

Further Reading

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Non-inflicted Causes of Death

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Introduction

Nomenclature has been changing in recent years, and proposals have been advanced that the term "accident" should be abandoned, as most noninflicted injuries are predictable and preventable. While the authors can see certain merit in this concept it is not completely correct, as some injuries are not preventable. In addition, "accident" is a standard classification that is used for manner of death and it is a word with which most readers would be quite familiar. For these reasons the term has continued to be used in this article when referring to traumatic episodes arising from noninflicted injury.

Causes of accidental death in childhood vary considerably depending on the age group and community studied, but overall are due in large part to motor vehicle-associated events. Other common scenarios involve drowning, thermal injuries, falls, poisoning, and choking. Mechanical suffocation is the second most important cause of accidental death in infants after motor vehicle crashes, compared to adolescents where drowning occupies the second position, well behind motor vehicle accidents. Firearm deaths occupy third position in 15–19-year-olds in the USA but are quite rare in this age group in other communities such as Australia.

Rates of accidental death are also quite different in different countries with rates as high as 30.5 per 100 000 of the population reported in the age range 1–19 years in the USA in the 1980s, compared to 10.8 per 10 000 for children under 4 years, 5.3 in 5–9-year-olds, 6.4 in 10–14-year-olds, and 29.2 in 15–24-year-olds in Australia in the 1990s. Reported rates from other countries are summarized in **Table 1**.

Motor Vehicle Deaths

Children may suffer lethal injuries in motor vehicle crashes as passengers, pedestrians, cyclists, or drivers (at older ages). The extent of injuries to passengers and drivers is determined by the circumstances of the crash, the speed of impact, and whether restraining harnesses or seatbelts were used. Unusual behavior by a parent prior to a single vehicle crash when all of

Table 1 Rates of accidental death per 100 000 of the population in the age range 1–19 years in various countries

USA	30.5
Canada	26.1
Norway	22.3
France	21.5
England and Wales	15.6
The Netherlands	13.1

the children in a family are in a vehicle raises the possibility of murder suicide.

Injuries in high-speed impacts are often multiple, involving head, chest, and abdominal trauma. Head injuries are often lethal in isolation with closed head injuries, atlantooccipital fracture–dislocations, and brainstem lacerations. Severe skull and facial skeletal fractures are often associated with lacerations and disruption of the brain. Other lethal injuries that are not uncommonly encountered are aortic transection, cardiac lacerations, flail chest, and extensive parenchymal disruption of the liver and spleen. Chest injuries may occur without significant rib fractures due to the elasticity of the juvenile ribcage.

While seatbelts and restraining harnesses have undoubtedly reduced morbidity and mortality from vehicle crashes, they must be correctly worn; additionally, caregivers must ensure that the child is tall enough for proper fit of standard, factory-installed restraint devices. Loosely fitting belts have been associated with carotid artery and aortic transection, in addition to other intraabdominal organ injuries when children have "submarined" under webbing. Shoulder harnesses that contact the neck in children who should be in booster seats may cause carotid artery injury. Booster seats that are used to elevate a small child in an adult car seat may predispose to slipping under belts if they are not firmly and correctly tethered. Unfortunately, assessment as to whether a seatbelt was used at the time of a fatal crash is often difficult, as markings on the skin may be absent or may be masked by the interposition of clothing.

Pedestrians tend to be older than passengers, reflecting increased independent mobility with age. Fatal injuries again involve the head and neck followed by the abdomen and chest. Childhood pedestrian fatalities occur in a bimodal distribution. In one group, a common scenario may involve a child running across a road into traffic without being aware of the dangers involved. A somewhat younger group involves events occurring in domestic driveways when a parent backs a vehicle over a toddler. Assessment of patterned injuries or the direction of brush abrasions may assist in determining a likely sequence of events.

Cyclists tend to be an older group: injuries occur in children or adolescents who are considered old enough to ride bicycles in, or near, traffic. Injuries may result from direct impact with a vehicle, or from secondary impact against the ground or another vehicle. Alternatively, falling on to bicycle handlebars has also been responsible for a percentage of injuries to abdominal organs.

Drowning

Children are at increased risk of drowning at two age ranges: under 4 years and 15–19 years. These particular ages reflect young children's inability to understand and/or deal with potentially dangerous environments, and risk-taking behavior by adolescents. The diagnosis of drowning may not be straightforward and depends on circumstantial evidence and the exclusion at autopsy of underlying natural diseases or inflicted trauma. As infants and very young children can be held under water with minimal effort by an adult, the possibility of homicide may be difficult to exclude in the absence of independent verification of the history.

Infants and young children are at particular risk of drowning in swimming pools and baths if left unattended. Curious children playing in water may overbalance into pools and be unable to extricate themselves. Baths also have slippery bases and sides and it may not be possible for an infant with immature physical coordination and strength to remove him- or herself from water once immersed. Parents and child carers may have been lulled into a false sense of security if an infant is in a bath with an older sibling, or in an infant bath seat (Figure 1). However, no infant should be left in water unattended

Figure 1 A 7-month-old boy was found drowned in a bath after slipping through the sides of a plastic baby bath seat and becoming entrapped. His $2^1/_2$-year-old brother was in the bath with him at the time. They were left alone by their mother.

by an adult carer, either alone or with a sibling. In fact, it has even been suggested that an infant may be at increased risk of drowning if left in a bath with a stronger, more active sibling. Bath seats may also tip over and entrap infants, and infants may slip down in such seats and get trapped under water.

Toddlers are also at risk of drowning in industrial buckets that are partially filled with water. Curiosity, combined with infants' high center of gravity, predispose children to slip headfirst into buckets and remain trapped. Similar deaths have occurred in infants slipping into toilet bowls.

The average time that infants who have drowned have been left unattended has been cited as less than 5 min, with only small amounts of water necessary to cause death. For example, children have drowned in as little as 5 cm of water in bathtubs.

At autopsy there may be changes such as skin wrinkling associated with prolonged immersion and marked pulmonary edema. However, if laryngospasm has occurred there may be minimal fluid present in the lungs. Diatom examinations and assessment of differential chloride levels between the right and left sides of the heart have not been proved as useful tests for drowning. Layer dissections of the neck and back may reveal occult bruising if a young child has struggled while being intentionally held under water.

An important part of an autopsy examination is exclusion of natural disease that may either have caused death while a child was in water, or incapacitated the child, facilitating drowning. A classic example of the latter situation is epilepsy. The effects of other natural diseases may be exacerbated by exercise from swimming such as myocarditis, aortic stenosis, hypertrophic cardiomyopathy, or prolonged QT interval resulting in a lethal outcome.

Thermal Deaths

There are a variety of types of lethal and nonlethal thermal injury, including flame burns which char skin and singe hair, scalding from hot fluids, and contact burns from touching hot objects. Scalds are the most frequent type of nonlethal accidental thermal injury in children, followed by contact and flame burns. In fatal cases, however, deaths from residential fires are more common than lethal scalds. Scalds may be due to spills, splashes, or immersion. Spills usually occur when a young child pulls over a container of hot liquid. Resultant injuries are characterized by irregular margins and a nonuniform depth of injury with an "arrowhead" pattern as liquids flow downward, cooling with distance, resulting in progressively shallower and narrower lesions. Accidental scalds usually involve the head, face, arms, and upper torso. Splash scalds occur when a child immersed in hot water moves and attempts to get out of the tub.

Children who die in house fires may be incinerated, making autopsy assessment difficult due to charring of remains, heat-induced fractures, and loss of body parts. In cases in which the circumstances are considered suspicious, radiographs may be helpful in identifying bullets or other foreign bodies prior to postmortem examination. More intact bodies may show cherry-pink discoloration typical of carbon monoxide toxicity. The presence of soot in the airways indicates that the deceased had been alive for some time during the fire. Absence of these features suggests that death occurred prior to a fire that may have been set in an attempt to disguise a homicide.

Occasionally, blood carboxyhemoglobin levels may be quite low. This will occur if there has been survival for some time after a fire with attempted resuscitation, resulting in blood carbon monoxide levels falling. It is also possible that cyanide poisoning derived from burning plastic materials contributed to death. Measurement of blood cyanide concentration may be helpful in cases where there is some doubt about the toxicity of the level of carbon monoxide. All bodies should be carefully assessed for signs of injury. Levels of carboxyhemoglobin may also not be high in cases where there has been a rapid flash fire involving solvents, as minimal carbon monoxide may be generated in such cases. Children may also have lower levels of carboxyhemoglobin than adults in fatal cases, as they may be more vulnerable to the effects of fire due to their higher respiratory rates and smaller airways that are more susceptible to mucus obstruction. Additionally, very young babies may succumb to carbon monoxide at lower environmental concentrations due to the higher affinity of fetal hemoglobin for the carbon monoxide molecule.

Cases are not uncommonly encountered where more than one child in a family has died in a house fire. This generally occurs because children tend to practice avoidance behavior rather than escape. For example, if a fire starts in a bedroom where a child has been playing with matches or a cigarette lighter, children may gather in the part of the room that is furthest from the flames rather than trying to exit by a door or window. Another scenario involves a young mother with multiple children who tries to gather the family to escape. In such a scenario, the bodies of the family members may be found commingled near an exit. In such commingling of remains, it is recommended that the remains be transported as a "unit" and separated in the autopsy suite. This allows the pathologist an opportunity to observe the spatial relationships that may alter thermal patterns on the

bodies, and prevents loss of potentially important evidence such as teeth or small bones.

Fire deaths have also occurred in cars when, for example, bored children have been playing with matches or electric car lighters. The interiors of modern vehicles are highly flammable and there may be papers, rubbish, and other combustible material present that will add to the conflagration. Again, children who were left in the front of cars may be found in the back seat due to avoidance rather than escape behavior. Locked car doors may be another impediment to escape. Deaths from thermal injuries may be immediate or protracted, resulting from sepsis with contributions from metabolic disturbances and dehydration.

Asphyxia

Asphyxial fatalities occur when there has been sufficient deprivation of oxygen to cause death. Accidental suffocation may occur in a variety of ways, including:

- smothering if the external airways are covered
- choking if there is obstruction of the internal airways
- external pressure on the chest in mechanical asphyxia
- oxygen deprivation in entrapment or where there has been replacement of oxygen by inert gases.

Sleeping Accidents

Infants and young children are at risk of asphyxial deaths in cribs from a number of causes. Smothering may occur if an infant becomes wrapped in, or pressed against, plastic that has been used to cover a mattress, crib, or pillow to prevent soiling (Figure 2). Particularly dangerous are thin plastic dry-cleaning or garbage disposal bags. Infants may also asphyxiate if they are left sleeping face-down on polystyrene-filled cushions or pillows. No specific autopsy features will be present in such cases, which will not be able to be differentiated from sudden infant death syndrome based purely on pathological findings. Such deaths demonstrate the importance of scene investigation, and integration of this information into the case facts considered when determining the cause and manner of death.

Strangulation occurs when external pressure on the neck obstructs blood vessels and air passages. The vessels become occluded at much lower external pressures than the actual airway, so the vast majority of strangulations are due to compromise of blood flow to the head rather than actual airway compression. Infants and young children are again at risk in their cribs and beds if clothing becomes caught on bolts or projections inside a crib. Once balance is lost, an infant may become suspended. If the child is not discovered immediately, hanging usually results in a clearly defined parchmented ligature mark around the neck. If the venous return is occluded prior to arterial flow into the head, an infant who has hanged may also have petechiae of the face and conjunctivae. Hanging may also occur if an infant slips down through the floor or side of a broken crib and becomes suspended by the neck, or hangs over the side of a crib or seat (Figure 3).

Wedging deaths may occur in cribs when a thick mattress does not completely fit the crib, leaving a space at the side into which an infant may roll or slip, or in gaps between pieces of sectional furniture or between "adult furniture" and an interior wall. Death results from a combination of mechanical asphyxia due to pressure on the chest and smothering

Figure 2 A young infant was found wedged between pillows and the plastic-lined side of the old borrowed bassinet. Fluffy pillows had been added by the parents. Suffocation had resulted when the infant's face had pressed against the plastic liner.

Figure 3 A young infant who had been left in an infant swing for several hours was found dead with his head hanging over the edge. Death was due to neck compression.

from the mattress covering the nose and mouth. Portable mesh-sided cribs are a particular problem if a thicker mattress has been added to the crib, as the distensible sides easily allow an infant to slip between the mesh and mattress and suffocate. Similar deaths have occurred when infants or toddlers have slipped between adult mattresses and walls or headboards. While facial and conjunctival petechiae are uncommon in such circumstances, lividity patterns and impressions from mattresses and bed clothing may help to corroborate histories.

Toddlers may also wind window cords or electric flexes around their necks and hang if their cribs have been left within reach of curtains or electrical appliances such as fans. Hanging may also occur if infants have been left unattended in seats with restraining harness such as infant bouncer or car seats.

Choking

Infants and young children are at risk of choking from inhaled foreign bodies; the peak age is between 2 and 3 years with most cases occurring under 5 years. Young children develop their incisor teeth well before their molars and so are able to bite off pieces of firm food before being able to masticate them adequately. Rounded and/or hard foods such as hot dogs, candy, carrots, nuts, and grapes present particular problems, as do parts of toys, balloons, metal screws, and plastic pen components.

While most children present with a history of wheezy breathing, gagging, or coughing, in some cases foreign bodies may remain asymptomatic until fatal airway obstruction occurs. Objects may also lodge in the esophagus rather than the airways. Deaths from inhaled foreign bodies may also be due to vessel perforation or sepsis.

Autopsy assessment of these cases may be difficult if the obstructing object has been removed during resuscitation attempts. Reliance on the history will be vital in formulating a likely cause and manner of death.

Mechanical Asphyxia

Fatal accidental compression asphyxia in childhood is a rare event. Younger children tend to be trapped under furniture or by industrial equipment while playing, whereas older children become trapped in excavated ditches or under motor vehicles in similar circumstances to adult traumatic asphyxial deaths.

Overlaying

Suffocation of an infant who has been sleeping in the same bed as an adult may be difficult to prove, given that there are usually no specific autopsy findings. Evaluation of these cases requires a clear description of the positions that the infant was placed to sleep in, and then found. Softness of the mattress, amount of bedding and parental fatigue, sedation, or intoxication should all be documented. Examination of parental clothing may reveal staining by serosanguineous infant oral secretions, demonstrating close contact between the parent and child at some time during the night. Although in some cases no decision may be able to be made, the diagnosis is sustainable when there is a clear history of an infant being found beneath the body, limb, or breast of a sedated adult.

Other Asphyxial Deaths

Accidental hanging may occur in adolescent males engaging in sexual asphyxia where hypoxia is used to augment solitary sexual activities. The presence of fetish items and pornography, and the secluded nature of the scene, usually mean that the diagnosis presents no difficulties.

Falls from Heights

While there is no doubt that infants and children may be severely injured or die from falls, there is considerable debate regarding the amount of force that is required to cause lethal injuries. Unfortunately, much of the early literature relied upon the unchallenged histories of cases, which were subsequently shown to be potentially unreliable. For example, if the presenting history in several series is believed, then short falls around the house are far more lethal than witnessed falls from considerable heights. The reality is that inflicted injuries sustained in the company of only one adult are often blamed upon accidents.

Characteristic features of inflicted craniocerebral trauma blamed on short falls are described elsewhere. The investigation of such cases requires a full autopsy with clear documentation of injuries, including radiographs, with independent verification of the history if possible and examination of the scene or scene photographs. Significant bruising and soft-tissue swelling may occur if a young child or toddler falls on to a hard sharp object such as a plastic toy or the edge of furniture (Figure 4).

Poisoning and Drug Toxicity

Deaths from poisoning tend to occur in two age groups: toddlers and adolescents. Young children are at risk of ingesting a variety of mainly household toxins while exploring. These commonly include plants, medicines prescribed for adult caregivers but left within reach of children, and household products such as cleaning agents, insecticides, and petroleum derivatives. Toxicological screening may be hampered

Figure 4 Thirty minutes after a healthy toddler was witnessed falling on to a table edge, significant periorbital edema and redness, with an overlying superficial abrasion, can be seen around the left eye. The injury resolved without sequelae.

by the range of possible substances ingested in a suspected case, and so a full inventory of household medications and materials should be obtained. Organic toxins may be even more difficult to detect.

Adolescents are at risk of unintentional death from illicit drug or alcohol ingestion, or suicide from intentionally ingested prescription medications. The nature of drug deaths varies depending on the community involved and toxicological screening should be based on local drug-taking practices.

Adolescent drowning and motor vehicle accident deaths are often characterized by alcohol consumption. Alcohol also causes death from respiratory depression, positional asphyxia, or inhalation of gastric contents. Rural communities have reported deaths from gasoline inhalation, whereas other types of volatile agent tend to be used in urban areas. Deaths from drugs such as cocaine and opiates tend to involve older individuals, although designer amphetamines have caused a number of deaths of adolescents in so-called "rave" dance clubs.

Electrocution

Electrocution deaths are uncommon in children and occur either when a child is playing with or near a faulty electrical device at home, or when an older child climbs a tree or building near high-voltage power lines.

Farm Deaths

Farms are quite dangerous places for children and adolescents: there are high rates of unintentional injury and death compared to cities. Deaths occur in young children from vehicle run-overs, falls, drowning, or from animal kicks. Older children may fall from horses or be fatally injured while using machinery unsupervised. Injuries tend to be extensive, with amputations, crush injuries, and evisceration.

Deaths Related to Animal Activity

In addition to falls from horses or kicks from farm animals, a range of potentially lethal injuries may arise from animals, including envenomation from spiders and snakes, anaphylaxis from insects, and mauling from domestic dogs. Dog attacks are characterized by lacerations and puncture wounds around the head and limbs: deaths may occur from cranial trauma, neck injuries, or exsanguination from deep lacerations involving vessels. Young children are particularly vulnerable to dog attacks as they are small, defenseless, and may provoke animals. Fatal dog attacks may involve more than one dog, with "pack behavior" precipitating the fatal event, despite otherwise placid behavior by all dogs but the "alpha" member of the pack (Figure 5).

Sports Deaths

Children playing sport may collapse due to the effects of occult or known underlying organic diseases, such

Figure 5 A fatal dog mauling of a 3-year-old boy who had been attacked by a number of mixed-breed dogs in a fenced backyard. Multiple sets of puncture wounds from canine incisors are present with patterned abrasions from dragging of incisors over the skin surface.

as asthma, hypertrophic cardiomyopathy, congenital heart disease (with or without surgery), and myocarditis, exacerbated by activity. Alternatively, trauma may play a role in death, with head and neck injuries accounting for a number of cases. A specific entity that may occur in children or adolescents who have been hit in the chest by a hardball or hockey puck is commotio cordis. Impact is followed by collapse with intractable cardiac arrest/arrhythmias.

Environmental Temperature-Related Deaths

As at all ages, deaths may be caused by exposure to high or low environmental temperatures. Infants are particularly predisposed to hyperthermia as they have high metabolic rates and are generally not able to extricate themselves from hot environments. Infants heavily swaddled in warm rooms and children left in cars on hot days are at increased risk of lethal hyperthermia. If exposure occurs over several hours, there may be evidence at autopsy of dehydration with skin slippage and elevated vitreous humor sodium levels. If, however, the child is extricated more quickly, autopsy findings may be minimal, and the diagnosis will be dependent on historical information such as first responder reports, and body temperature on arrival at the emergency department. Children may die from lethal cardiac arrhythmias if exposed to low environmental temperatures.

Hospital Deaths

Unintentional deaths of children in hospital may result from failure to monitor adequately or from misadventure due to surgery, anesthesia, drug therapy, or diagnostic procedures. The investigation of such cases requires careful review of the hospital record, including surgical and anesthetic notes and medication history. Equipment that may be implicated in a death should be seized and independently examined, and toxicological analyses should be conducted for a full range of medications, not only those prescribed to the victim.

Conclusion

Full investigation of childhood deaths caused by unintentional trauma requires a clear description of the lethal event with corroboration of the history by independent observers if possible. In fact, many of these deaths in infancy may be misdiagnosed as sudden infant death syndrome if an adequate scene investigation with integration of information into the case history has not occurred. Complete investigation of such deaths is important not only to determine the correct cause and manner of death in an individual case, but also for public health reasons to identify potentially hazardous situations or products. The likelihood of an injury from a described incident must be determined from the autopsy findings and a reconstruction of events. The developmental level of a child must also be taken into account, particularly in very young children, before an event can be accepted as a plausible cause of death or not.

See Also

Children: Physical Abuse; Sudden Natural Infant and Childhood Death; **Falls from Height, Physical Findings:** In Children; **Sudden Natural Death:** Cardiovascular

Further Reading

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