

# Sudden Infant Death Syndrome

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ent with sudden death, but is not directly responsible for it. Several possibilities are suggested: chronic hypoxemia; maternal cigarette smoking; nutritional deficiency; or inborn errors of metabolism inhibiting myelin formation. This theory has much appeal since it unifies the epidemiological observations, the individual and collective clinical and medical histories of SIDS cases, and the post-mortem findings into an evolving sequence of events leading to a final common pathway for death.

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## ACCIDENTAL INJURIES

—by Kenneth W. Feldman

**Understanding patterns of normal childhood injury helps us recognize the exceptional patterns that result from abuse.**

It is important for pediatricians treating abused and neglected children to be knowledgeable in unintentional as well as intentional injuries. Understanding patterns of normal childhood injury helps us recognize the exceptional patterns that result from abuse. Knowledge about unintentional injuries also provides an indirect means of understanding the forces and mechanisms of intentional injuries. Without them, we are dependent on extrapolation from animal and biomechanical studies alone. For example, studies of head injuries resulting from childhood falls and bicycle accidents have obvious implications for understanding abusive head injury thresholds. Although both accident scenarios begin with a linear deceleration, these initial forces often impart rotational decelerations on the brain similar to those causing injury in shaken and/or beaten infants. Unintentional injuries also interface with issues of child neglect. Where does the boundary between "acts of God" and caretaker negligence lie?

Accidents are currently the leading cause of death between ages one and 24 years, although the death rate of 27.2 per 100,000 in 1989 is 29% less than that of 1975 (Hoekelman, 1992).

### Motor vehicle accidents

Motor vehicle injuries continue to be the leading cause of accidental death in childhood, accounting for two-thirds of these deaths (Hoekelman, 1992). From 1975 through 1987, the

death rates in auto accidents for children up through age 14 years declined slowly but steadily. It is encouraging that the rate for infants to four-year-olds declined from 4.5 to 3.7 per 100,000, associated with an increase in auto restraint use to 80% (Agran et al., 1990). However, rates in older adolescents have been more erratic, rising from a low in 1983 to 33 per 100,000 in 1987. In 1987, 31% of older adolescents involved in fatal crashes had elevated blood alcohol levels. At the same time, only 25% of older teens used seat belts. Injury rates for adolescents are 75 times the fatality rates.

A number of injury prevention strategies have been considered or implemented. Adolescent risk might be modified by raising the age at which a person may receive a driver's license or drink legally. Night driving curfews or license restrictions and lower blood alcohol laws for teens have been considered. Passenger protection has been addressed by uniform restraint laws and passive passenger protections such as air bags and automatic seat belts. Ignition lockouts could be devised to prevent starting the engine if the driver had detectable breath alcohol or was unable to complete a rapid dexterity task. Roadway design to minimize traffic conflict may also reduce injuries.

In addition to motor vehicle occupants, pedestrians and bicyclists are injured in motor vehicle accidents. An estimated 50,000 child pedestrians are injured and 1,800 die annually (Rivara, 1990). They accounted for 15% of unintentional fatal

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childhood injuries in 1985. The highest rates of fatal pedestrian injury (5.4 per 100,000) are in the early school-age child. At this age, mobility and independence are great. Often safety skills are overestimated by caretakers. Many injuries result from "dart out" events at mid-block or between parked cars. However, even marked crosswalks are not safe, seeming to provide children with more of an impression of security than really exists.

In the United States, prevention has taken the approach of educating children in safe street habits; this has been only marginally successful. Other approaches include strict enforcement of pedestrian laws for motorists and physical separation of pedestrians and motor vehicles (e.g., pedestrian overpasses).

**Unintentional injuries also interface with issues of child neglect. Where does the boundary between "acts of God" and caretaker negligence lie?**

Bicyclists and motorcyclists are involved in both solo accidents and collisions with motor vehicles. Estimates for fatalities and injuries are 500 and 40,000 for bicyclists and 1,000 and 45,000 for motorcyclists annually (Division of Injury Control, 1990). Other than cyclist education, safety helmets have the greatest potential for injury reduction. They have proved successful in reducing brain injuries for both bicycle and motorcycle riders, but current models have been less

successful in preventing lower face injuries in bicyclists (Thompson et al., 1989). Currently used bicycle helmet designs use a 300g energy absorption threshold. However, very little data are available on optimal energy absorption thresholds and dissipation curves.

## Drowning

Drowning is the second leading overall cause of accidental death in childhood, but under five years of age it surpasses both motor vehicle occupant and pedestrian injury (Division of Injury Control, 1990). Drowning causes vary dramatically with climate and socioeconomic status (Wintemute, 1992). For example, 89% of drownings in Los Angeles are in residential swimming pools, while in Seattle only 52% occur in pools, many of which are public (Wintemute, 1992). Inadequate barriers to toddlers and young children combined with lapses in caretaker supervision were the primary predispositions. Many of the victims were not swimming, but gained access to the pool while engaged in other play activity. As with pool immersions, immersions in natural bodies of water involve the unsupervised child who has unguarded access to the water. Adolescent immersions occur primarily in pools and natural bodies of water. Some degree of adolescent bravado, activity exceeding athletic capability, and/or intoxications are common predispositions.

Bathtub immersions are primarily limited to young or neurologically impaired children. They account for about 10% of immersion events (Wintemute, 1992; Lavelle et al., 1993). Most often

caretakers misinterpret the safety of toddlers bathing alone or infants bathing with other preschool children. Supervising adults may also be temporarily distracted, as by phone calls. Up to two-thirds of bathtub immersions may have indication of either abuse or severe neglect (Lavelle et al., 1993; Feldman et al., 1993).

Supervisors of children with development or motor impairments may have age appropriate, but skill level inappropriate, expectations of their child's safety. Further, seizures are a risk factor for accidental submersion. Less frequent drownings occur in toilets and in buckets, especially the plastic five-gallon type. Both are the right size and height for toddlers to tip into head first and become hopelessly unable to extricate themselves. Hot tubs and spas present another risk, particularly because the intake to the pump can entrap a child's hair.

## Burns

Burns and fire injuries (2.3 annual fatalities per 100,000) follow drowning as a cause of accidental childhood fatality (Division of Injury Control, 1990). Deaths due to house fires have decreased with increasing use of smoke detectors (McLoughlin and Brigham, 1992). Clothing ignition injuries also have been reduced by legislation banning flammable fabrics (McLoughlin and Brigham, 1992). Many other ignition sources remain and are potentially amenable to prevention. For example, childproofing of cigarette lighters could reduce one source of burns of exploring children. Scald burns remain the most frequent source of hospital admission in preschoolers. Seventy-two percent of admissions for burns under two years of age result from scalding, with foods and beverages accounting for the majority (McLoughlin and Brigham, 1992).

Child supervision and improved safety design of cups and cooking equipment are required for prevention. Twenty-three percent of infant and toddler scalds result from tap water (McLoughlin and Brigham, 1992). Temperature-limiting valves on faucets can prevent these injuries (McLoughlin and Brigham, 1992), but limitation of water heater temperatures through voluntary consumer action, legislation, and industry standard changes have proved effective in reducing the frequency and severity of these injuries (Erdmann et al., 1991). As water temperatures have fallen, the percentage of tap water scalds caused by abuse has risen to 50% (Erdmann et al., 1991).

## Falls

Falls present the next most frequent cause of childhood accidental fatality (0.5 annual fatalities per 100,000) (Division of Injury Control, 1990). Twenty-five percent of significant head injuries in San Diego resulted from falls (Kraus et al., 1990). The interface with abuse is discussed in Dr. Chadwick's article elsewhere in this publication.

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**In many cases, evaluation of agent, environment, and victim factors may suggest prevention strategies. In general, passive strategies that do not require repetitive child or caretaker actions are more effective than active ones.**

Suffice to say that significant injury usually is the result of a significant fall. Although simple skull fractures, epidural hemorrhages, and fractures of the clavicle, distal humerus, forearm, and tibia may result from short toddler falls, subdurals, major brain injury, and rib and proximal extremity fractures rarely result (Paez et al., 1993; Thomas, 1991). Running and twisting events may result in spiral femur injuries in toddlers (Thomas, 1991). Case series of accidental falls are likely to be contaminated with abuse cases, unless injury scenarios are carefully corroborated and other evi-

dence of inflicted injury is carefully sought and excluded. Open or unguarded upper story windows cause a particular risk for accidental falls. Building code changes requiring window grates on upper-story apartments have been successful in reducing these injuries (Bergner et al., 1971). Similarly, code regulations for porch rails can reduce falls from elevated porches. Although stairway falls usually act like a series of short and relatively benign falls, children in infant walkers are at heightened risk. The walker seems to present the infant's head to trauma (Joffe and Ludwig, 1988). Playground equipment

can allow children to climb to and fall from significant heights (Werner, 1982). Standards for energy absorbent surfaces under play equipment provide a significant countermeasure.

## Strangulation

Playground equipment and many household infant furniture items such as cradles and high chairs present significant strangulation risk (Werner, 1982; Feldman and Simms, 1980). Clothing catch points, design cutouts, wide crib slats, defective crib side rails, and high chair trays or waist belts that allow submarining can entrap infants' heads and necks (Feldman and Simms, 1980). Children can become asphyxiated when wedged between furniture. Their necks can become entangled in dangling ropes and cords (e.g., curtain cords)

## Prevention

The sources of accidental childhood injury are innumerable, but repetitive scenarios can be recog-

nized (Feldman, 1980). They thus become not "accidents" but predictable interactions of child behavior and development with the environment. In many cases, evaluation of agent, environment, and victim factors may suggest prevention strategies. In general, passive strategies that do not require repetitive child or caretaker actions are more effective than active ones.

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# ABUSIVE HEAD INJURY

—by Wilbur L. Smith

The leading cause of death among abused children is head injury. Estimates of the actual prevalence of child abuse-related head injury are imprecise and probably artificially low owing to difficulties in diagnosis, reporting, and case finding. In 70% of children documented to be suffering from abusive head injury, there is concrete evidence that the victims have suffered an injury prior to the one that brought them to attention (Alexander et al., 1990a). It is reasonable to assume, therefore, that some children's brain injuries are never detected and that there is a large degree of underdiagnosis, with an unknown number of chil-

dren suffering subclinical abusive head injury, making published prevalence data artificially low.

Allowing for these difficulties, it is possible to estimate an admittedly conservative prevalence figure. Most abusive head injuries occur in children younger than two years of age; therefore, this is the population to which the prevalence figures are most germane. According to the 1992 figures available through the Department of Health and Human Services there were approximately 8 million children in the United States, age 0 - 2 years.

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