Crib Death: A Biobehavioral Phenomenon?

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Abstract
In the developed countries, more children under 1 year of age die of crib death (sudden infant death syndrome, SIDS) than of all other causes combined. Researchers and clinicians have proposed many possible causes of SIDS, but the abrupt, unexpected death of some babies remains mysterious and frightening. Although infant behavior may explain some of these deaths, scant attention has addressed behavioral characteristics of babies who die without medical explanation. Any explanation of SIDS must account for the fact that most SIDS deaths occur at 2 to 5 months of age, acknowledging that a protective mechanism spares babies before 2 months but then disappears. The respiratory occlusion reflex serves as an initial defense against suffocation and can provide such an explanation. Infantile reflexes wane, after providing opportunities for learned responses to be acquired. During this well-documented neurobehavioral transition from subcortical to cortically mediated responding, some babies, viable for the first 2 months, may become especially vulnerable if they fail to acquire sufficiently strong defensive behaviors needed to prevent occlusion after the waning of the life-preserving reflex. Recent success of back-to-sleep directives, urging that babies sleep on their backs to avoid suffocating, supports this hypothesis.

Keywords
sudden infant death syndrome; crib death

Until about 40 years ago, when a baby died of no apparent or diagnosable cause, the medical examiner was likely to state that the death was due to pneumonia. Aggrieved parents usually accepted this medical explanation, believing their baby died of a “disease.” In the 1960s, however, parents’ displeasure with gratuitous diagnoses and chagrin over false accusations of neglect and abuse, among other factors, led to a change in attitude. A small group of sympathetic pediatricians and pathologists joined parents in lobbying for research into the causes of crib death, or sudden infant death syndrome (SIDS). Doctors and researchers began to question the processes underlying the death of infants in the absence of foreboding signs of illness. Funds were invested in crib-death research and counseling for families trying to cope with SIDS. This collaboration of parents, practicing physicians, and researchers provided helpful but inconclusive insights that pointed to multiple causes of SIDS (Hunt, 2001). It also led to great disappointments, documented by Firstman and Talan (1997), when it was discovered that some cases previously diagnosed as SIDS were infanticides. Although murder is itself a behavioral act, there remain other behavioral issues—in particular, the neurobehavioral development of the baby victim—to be studied further in connection with SIDS. It is my contention that insufficient attention has been paid to the likelihood that the behavior of babies plays a significant role in infant deaths that occur without medical explanation. The importance of discovering the cause of crib death is made poignant by the fact that more infants die of SIDS than of all other causes combined.

The definition of SIDS, established in 1969, has been solidified through legislation (upon recommendation of a consensus team of experts assembled by the National Institute of Child Health and Human Development) as the sudden death of an infant younger than 1 year that remains unexplained after a thorough investigation including complete autopsy, examination of the death scene, and review of the clinical history (Hunt, 2001, p. 346). Even after refinements of diagnosis, however, the phenomenon remains a mystery, and thousands of cases are still diagnosed as “unexplained.” The term unexplained, of course, indicates that the SIDS phenomenon remains a mystery, and that SIDS is essentially used as a residual diagnosis (i.e., the SIDS designation is used after all plausible causes are investigated and discarded). Although a diagnosis of “no finding” can hardly be satisfying, the designation of a medically accepted “syndrome” has had the effect of minimizing parents’ feelings of guilt and averting callous accusations, by reducing the likelihood of implied or abuse.

THE SIDS PHENOMENON
In the developed countries, the most common cause of death in the first year of life after the first few days is SIDS, which usually occurs at night while the infant and family sleep. In the absence of anything more than circumstantial evidence, the death is sometimes attributed to an upper respiratory infection, such as a cold. Usually, the baby is regarded as having been normal and of good health when death occurred. The incidence of crib death today in the United States is between 2 and 3 deaths per 1,000 births, higher for Blacks than Whites, and for males than females.

Raring (1975), who lost a child to SIDS, attempted to arouse medical concern when he wrote that the disorder probably killed 10,000 to 20,000 infants in the United States each year. Numerous hypotheses to account for SIDS had been advanced unsuccessfully, he said, including disorders of the thymus gland, prematurity or low birth weight, accidental overlaying (rolling over on the baby while sleeping), suffocation by vomit, hypersensitivity to cow’s milk, immature heart, sleep disorder, calcium or magnesium deficiency, prenatal or postnatal drug abuse, air pollution, fluoridation of the water supply, parental smoking, use of bleach in diapers, venomous insect bite, and apnea (a brief interruption of normal respiration, usually lasting 5-10 s). He chided medical science and the government for not searching deeply enough for answers. Interestingly, Raring (1975) dismissed the possibility of suffocation:

Doctors have made very carefully controlled experiments which prove conclusively that even the smallest and weakest of babies have no trouble at all in squirming out from under unwanted coverings. All parents know that well. Besides, the idea is incompatible with the well-known facts that the very young baby and therefore the one least likely to be able to put aside covers and to turn its head away from the pillow, is far less likely to
become a crib death victim than are older, stronger babies. (pp. 63-64)

Raring was correct that very young babies are less vulnerable to SIDS than are older infants, but he drew the wrong inference from this because he did not consider an important behavioral feature of early infant development. In this article, I propose a psychobiological explanation for vulnerability to SIDS that is based on the behavior of the baby and the developmental course of infantile behavior. This psychobiological hypothesis can account for the fact that about 85% of SIDS deaths occur between 2 and 5 months of age. I return to this hypothesis after discussing the back-to-sleep movement, which provides context for my proposal.

THE BACK-TO-SLEEP MOVEMENT

Many hypotheses as to the origin of SIDS have emerged in recent years, and some studies have documented lifestyle conditions, such as smoking, bed sharing, and alcohol ingestion, that are correlated with heightened risk of crib death. However, no specific hypothesis has yet earned empirical support. Moreover, no one has offered a hypothesis taking into consideration both babies’ developmental stages and environmental events impinging on babies in the early months of life, along with the apparent success of a recent effort to reduce the SIDS rate through a behavioral change—the back-to-sleep movement.

A 1992 recommendation by the American Academy of Pediatrics and a 1994 campaign initiated by the U.S. Public Health Service and a consortium of organizations suggested a simple change in parental and caretaker behavior—placing babies on their backs for sleeping (Task Force, 2000). This change may already have had a marked effect on the occurrence of crib death, as in the 8 years following the 1992 recommendation, SIDS declined to half its previous rate (see Fig. 1).

Back sleeping might have addressed a multiplicity of causes of SIDS. Any conditions, such as maternal smoking or prematurity, which might compromise defensive responses to inadvertent smothering, could be well served by protection of the respiratory passages from blockage. Still, the data constitute at least tentative corroboration of the usefulness of this behavioral intervention.

The question remains as to how the back-to-sleep movement may have reduced the crib-death rate. I propose that back sleeping spares those infants who have a behavioral insufficiency that might cause them to succumb to accidental smothering (Lipsitt, 1976; Swift & Emery, 1973) when placed to sleep on their abdomen. In the next section, I discuss the processes through which the initial reflexes of the newborn are eventually supplanted by learned behaviors, and the hazard that may be associated with the transitional phase for some infants.

A VIABLE NEUROBIOLOGICAL HYPOTHESIS

Epidemiological and actuarial data indicate that there are some conditions that might predispose a child to SIDS (e.g., Prostotos, Carpenter, McWeeny, & Emery, 1973; Scragg et al., 1993). Babies who are born to young mothers who smoke or to mothers who receive inadequate or late prenatal care are at special risk for SIDS, as are babies born under compromising conditions, such as with the umbilical cord around the neck. In the United States, SIDS babies are disproportionately Black, of low socioeconomic level, male, and premature. What might explain these risk factors? Perhaps the answer lies in the reflexes with which human infants are born. Babies vary in the intensity and threshold for elicitation of these reflexes (Brazelton, 1973; McGraw, 1943), and these differences could help explain vulnerability to SIDS. I propose that the factors just mentioned contribute to later risk of crib death because they tend to lower reflex strength and ease of elicitation soon after birth. That is, initial nonfatal risks may nonetheless contribute to greater risk for SIDS at a later age. This is because in the orderly developmental course of neuromotor capacity (McGrav, 1943), the reflexive responses sufficient to protect the baby early in life inevitably wane as the nervous system develops, and are supplanted by learned responses. During this transitional period when brain and behavior are developing, newborns with weak defensive reflexes are in greater jeopardy than are newborns with stronger reflexes, because learning depends on earlier reflexes of some minimal strength; that is, the behavioral responses embodied in reflexes form the basis for later learned behavior.

More than 60 years ago, before SIDS had been identified, the eminent psychobiologist and developmental researcher Myrtle McGraw noted behavioral transitions that she believed were related to important changes in brain structure and function during the first year of life. Noting that there are gross differences between the cerebral cortex of the human brain (the outer layer of gray matter) and the subcortical brain structures, she documented carefully the developmental progress of infantile reflexes, especially evident in the first weeks of life, and presumed they were under the control of subcortical structures. She showed empirically that these reflexes, such as the grasping, stepping, and swimming reflexes, gradually wane in strength.

During those first few weeks of life, the reflexes that were initially obligatory in execution become slower, more deliberative, and seemingly voluntary. McGraw labeled the first, reflexive systems Type A behavior and the eventually achieved deliberate type of response Type C. McGraw considered Type A behavior to be mediated principally by the brain stem (lower brain structures) and Type C to be mediated by the cerebral cortex as myelin tissue (sheathing around the nerves) matured and connections among neurons proliferated. McGraw noted a third type of response, which she called Type B, because it came between Types A and C chronologically. Type B responses represented what she observed to be curiously disorganized and confused behavior, which she regarded as indicative of two conflicting psychobiological processes, the Type A process that came before and the Type C pattern that followed. (As an example, the developmental changes in the swimming reflex are depicted schematically in Figs. 2 and 3). When asked to elaborate on the state of the baby during this intermediary period, she replied that at this stage, “the baby doesn’t know whether he is supposed to be a reflexive creature or a learned organism” (personal communication, May 25, 1979).

Of special note is that the onset and peak of McGraw’s intermediate period of confusion occur largely during the 2- to 5-month age period. The
peak of confusion for most reflexes McGraw studied was around 130 to 150 days of age, approximating the period during which most crib deaths occur. I believe that an aberration in the transitional period of a respiratory reflex known as the respiratory occlusion reflex (or respiratory defense response) may contribute to the risk of crib death.

The respiratory defense response involves the baby reacting to any covering of its nostrils and mouth. This reflex can be assessed in the first days of life and appears in standardized scales of infant behavior (e.g., Anderson & Rosenblith, 1971; Brazelton, 1973). It was described in detail by Gunther (1961; see also Swift & Emery, 1973, and Anderson & Rosenblith, 1971) as a "fixed action pattern" (i.e., a chain of responses that occurs in a generally fixed order) in which the infant shakes its head from side to side, pulls its head back, and brings its hands up to the face when its respiration is compromised (this can happen during breast-feeding). Facial vasodilation (blushing, an emotional response) occurs if none of these prior responses succeeds in freeing the respiratory passages. The end point of the response pattern is crying, with a thrust of the offending object away from the baby’s face, whereupon a great sigh of relief frequently occurs. This reaction suggests that a learning process is under way, with the final fail-safe link in the fixed reaction pattern being highly reinforcing. Gunther, in fact, noted that normal babies often show signs of learning to avoid occlusion after just one or two experiences.

The respiratory occlusion response does seem to be related to the risk of crib death. The normal newborn, when placed face down on a surface, is usually capable of lifting its head and turning to one or the other side, freeing the face of occlusion. However, Anderson and Rosenblith (1971) found that newborns with a weak respiratory occlusion reflex are more likely to succumb to SIDS later in the first year of life than are babies who manifest vigorous thwarting of occlusion as newborns.

In a study of infants’ responses to nasal occlusion in which large numbers of newborns and 6-week-old infants were compared, Swift and Emery (1973, p. 950) found that 44% of the older infants but only 17% of the newborns “were wholly or partially unable to establish an oral airway within 25 seconds.” Thus, the newborns had a stronger response to respiratory occlusion than the older infants did. Evidence from this study, carried out by pathologists, is consistent with the hypothesis that the respiratory defense reflex protects babies from SIDS in the first 2 months of life, and that the gradual diminution of reflex strength increases vulnerability over the ensuing few months. Infants' responses were measured with a scale that included behaviors critical for self-protection, such as "signs of protest build-up,“ “avoidance reactions, “crying persists,” and “no struggle or cry.” Another team of pathologists, Naeye, Messmer, Specht, and Merrit (1976), were among the first to call attention to “temperamental” characteristics as relevant to crib death. They found that when parents compared a surviving child with a SIDS sibling, the crib-death child was reported to be more easygoing, less fussy, and quieter than their surviving siblings; these characteristics might be indicative of underresponsiveness or a lack of strong defensive behaviors.

Recently, Lijowska, Reed, Mertins Chiodi, and Thach (1997) studied the behavior of infants 2 to 26 weeks old when subjected to respiratory compromises. They found four highly stereotyped behaviors: sighs, startles, limb thrashing, and full arousal (eyes open and crying). These behaviors, indicative of strong defensive responding to respiratory challenges, seem comparable to Gunther’s (1961) description of infants' defensive fixed actions when regaining respiratory control over threatened occlusion. Lijowska et al. reported a stereotypic sequence analogous to Gunther’s and observed that the baby was “variable in effecting the bedden covering the airway” (p. 226). This was a remarkable demonstration (from the laboratory of research pediatrician Thach) of the variable effectiveness of coping behaviors for retrieving sufficient levels of fresh air following periods of oxygen deprivation.

I am proposing, then, that (a) strong reflexive behaviors that protect the infant from respiratory occlusion during the first months of life are gradually replaced by learned, deliberate responses and (b) if these reflexive behaviors wane too quickly, before learned behavior is sufficient, or if they are not strong enough to enable adequate learning, the infant is in jeopardy. Thus, a biobehavioral theory based on McGraw’s developmental progression suggests that infants with reflex insufficiency are vulnerable to crib death during the period between 2 and 5 months because of deficits in learned, adaptive, life-saving responses (Lipsitt, 1976, 1979).

CONCLUSIONS AND IMPLICATIONS
The new cautions that babies should be placed on their backs for sleeping, along with the data (see Fig. 1) suggesting that back sleeping has reduced the SIDS rate by about 50%, support the contention that behavioral factors are relevant to an understanding of crib death.

A fair assessment of our state of knowledge concerning the causes of SIDS must include the caveat that it is still a mystery. Nonetheless, the back-to-sleep movement, formally introduced in 1992 by pediatricians and reinforced by a governmental consensus statement in 1994, was followed by a significant decline in SIDS cases, and this apparent success supports the supposition that respiratory occlusion plays a role in SIDS. SIDS appears to be due to suffocation that occurs when some babies lying prone fail to lift their heads and free their mouths and nostrils during a respiratory challenge. Some infants are more agile than others in responding defensively to smothering stimulation, and even those with fairly weak reflexes are generally able in the first 2 months to maneuver into a safe position when respiration is threatened. However, I suggest that infants with especially weak reflexes or high thresholds for eliciting the respiratory defense response are in extra jeopardy when threatened with smothering during the period when reflexes wane and cortically mediated learned responses must take their place. If the transition from predominantly reflexive to learned behavior does not take place seamlessly, because of a weak or rapidly waning respiratory defense reflex, the child of 2 to 5 months will be at greater risk for SIDS.

There seems a good basis for continuing to caution caretakers to place infants on their back during sleep. There may be an even greater urgency to provide babies with ample exercise in the prone position while they are awake and their caretakers are present, so that the infants may practice
maneuvers important to keeping respiration clear of obstruction. An argument may also be made that infants should be given deliberate practice in resisting respiratory occlusion so that during the transition when the respiratory defense reflex wanes, they are more likely to engage in behaviors aimed at removing the offending object.

An enhanced program of governmentally sponsored research on the reflexive behavior of infants in the early months of life should be mounted, with special focus on the transitional stage marked by the 2- to 5-month critical period associated with crib death. Studies of learned reactions in the first 6 months of life, the neuromuscular maturation of the infant, and environmental hazards that may contribute to inadequate responsiveness by the baby must be carried out using research designs that acknowledge interacting conditions rather than single antecedents as causing the tragic deaths of thousands of infants.

**Recommended Reading**
Firstman, R., & Talan, J. (1997). (See References)
Swift, P.G.F., & Emery, J.L. (1973). (See References)

**Acknowledgments**–I thank Matthew S. Goodwin for helping with the figures, and Marian Willinger of the National Institute of Child Health and Human Development for providing recent data on SIDS rates.

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