

PAPER

PATHOLOGY/BIOLOGY

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Household Furniture Tip-Over Deaths of Young Children*

ABSTRACT: The potential for the injury or death of a child resulting from the tip-over of a piece of household furniture or a domestic appliance has not been previously well recognized. We reviewed nine accidental deaths of young children that resulted from avoidable residential hazards and/or lapses in supervision of the children by their caregivers. The offending household items included televisions, bedroom dressers, a kitchen stove, and a lounge chair. The causes of death were mechanical asphyxia, blunt trauma, and combined blunt head trauma and asphyxia. All of the deaths could have been prevented by appropriate anchoring of the piece of furniture and/or closer supervision of the child. A thorough multidisciplinary investigation is essential in establishing the cause and manner of death in such cases and in identifying risk factors that may aid in the prevention of future childhood deaths.

KEYWORDS: forensic science, medicolegal death investigation, childhood deaths, furniture tip-overs

Although many investigators have recognized that unsafe sleeping conditions such as bed sharing (co-sleeping) and/or compressible sleep surfaces play a causal role in many sudden, unexplained infant deaths, there is a dramatic increase in the incidence of accidental deaths when children reach the developmental stage of mobility (1). Accidental deaths in childhood result from falls, poisoning, drowning, fires/burns, transportation-related deaths, and deaths caused by foreign body inhalation (<http://www.cpsc.gov/cpsc/pub/pubs/5004.pdf>). Examples include poisonings resulting from a child's having access to household products containing hazardous chemicals or to objects left within the child's reach that could be swallowed, and deaths caused by hyperthermia when children are inadvertently left in closed vehicles. The majority of these deaths occur in the child's residence, and many result from avoidable hazards in the home and/or lapses in supervision of the children by their caregivers, in some instances because of impairment of the caregivers owing to exhaustion or substance abuse.

The majority of childhood accidental deaths in the home relate to readily recognizable domestic sources of danger such as drowning deaths caused by inadequate barrier mechanisms preventing the child from having access to residential swimming pools. Other domestic hazards are less well recognized. Although childhood deaths resulting from tip-overs of household furniture or appliances are uncommon (2–4), the US Consumer Products Safety Commission (CPSC) (<http://www.cpsc.gov/cpsc/pub/pubs/5004.pdf>) has warned the public of the risk of deaths owing to heavy pieces of

furniture or television sets falling on young children. However, the forensic literature contains little information on childhood deaths resulting from furniture tip-overs.

The aim of this report is to review the causes of death and the pattern of injuries seen on a series of childhood deaths resulting from household furniture tip-overs and to attempt to identify risk factors that may aid in the prevention of future such deaths.

Materials and Methods

Nine cases were reviewed in which the death of a child was attributed to a household accident in which a piece of furniture or a domestic appliance toppled over and fell on the child. The cases were identified from medical examiner files and through the consultation practice of one of us (BCW). All cases were investigated by a medicolegal death investigator from the medical examiner's office, as well as by a local law enforcement agency, and a complete autopsy was performed on the body of each decedent. The investigators' reports and the reports of the postmortem examinations were reviewed for the cause and manner of death and for the presence and nature of injuries as well as for evidence of pre-existing natural disease. Information pertaining to the scenes and circumstances of the deaths was obtained from the medical examiner investigators' reports and from the reports of the investigating law enforcement agencies. Postmortem toxicologic studies were performed in all cases by private laboratories contracted by the medical examiners' offices. In only one case were the caregivers asked to submit to toxicologic testing at the time of the child's death.

Results

The nine deceased children included five boys and four girls. Their ages ranged from 17 months to 6 years, with all but one child being younger than 5 years. Six children were white, and

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three were African-American. The offending objects included four television sets, three bedroom dressers, one stove, and one reclining lounge chair (Table 1).

In six cases, the children were either pronounced dead at the scene or upon transport to a hospital. Two of the children survived for several hours. One 3-year-old boy, upon whom a television had fallen, appeared to his parents to be unharmed at the time of the incident but developed abdominal pain a week later and was found to have a lacerated diaphragm with herniation of abdominal organs into the chest cavity.

In all cases, the cause and manner of death were initially listed as "pending," because in all cases the question of child abuse by either inflicted injury or homicidal suffocation was raised. Subsequent to law enforcement investigation, as well as review of microscopic slides and laboratory studies, the cause of death was attributed to blunt head trauma in three cases and thoracoabdominal trauma in one. Four deaths were certified as being asphyxial in origin, with the weight of the heavy object impeding the child's breathing. The cause of death in the remaining case was attributed to a combination of asphyxia and blunt head trauma. Petechial hemorrhages of the conjunctivae, sclerae, and/or skin were seen in three of five cases in which asphyxia was a factor.

The autopsies revealed no congenital abnormalities or evidence of pre-existing natural disease processes that could have contributed to death in any case, and all postmortem toxicologic studies were negative for drugs or alcohol.

The following three illustrative cases are presented in greater detail.

Case 1

A 4-year-old black male child was being watched by his grandmother, who had observed him become excited over a television program and shake a 27-inch television that was on top of a small, wheeled cart designed for a microwave oven. However, he continued to shake the unit, when the television and cart suddenly toppled forward, with the television landing on the child and hitting his head. He was taken by ambulance to a local hospital, where resuscitation efforts were unsuccessful and he was pronounced dead in the emergency department. He was noted to be lean and appeared younger than the stated age of 4 years. His family stated that he had been born prematurely and had health problems since birth. Florida's Department of Children and Families and local law enforcement agencies had no prior involvement with the family.

The only external injury identified at postmortem examination was a 0.6-cm contusion on the left cheek. Reflection of the scalp revealed subgaleal hemorrhage in the right temporal region and hemorrhage in the right temporalis muscle. There were multiple skull fractures including a basilar skull fracture, hinge type, which extended through both middle cranial fossae and the sella turcica,

in addition to fractures of the temporal bones bilaterally. The brain appeared swollen, with occipital notching and flattening of the unci, and showed basilar subarachnoid hemorrhage. The remaining internal examination was unremarkable. No congenital malformations or pre-existing natural disease was identified. The cause of death was certified as blunt head trauma, and the manner of death was accidental.

Case 2

A 17-month-old white male child was found by his mother beneath a bedroom chest of drawers. He had been left playing in the room alone, with his door shut, while his mother took a bath. The mother estimated that she left her son alone for c. 10 min. Her three elder children were in another room watching television and playing video games. The mother lifted the dresser off the child and found him to be unresponsive. Emergency medical services responded and found the child pulseless and in asystole. He was pronounced dead in the emergency department in a local hospital. The mother stated that she had never seen her son attempt to climb the dresser and that she put him in his room when she needed time alone because she thought that was the safest place for him. The Department of Children and Families and local law enforcement had no prior involvement with the family.

The autopsy performed on the body of the well-developed, well-nourished child revealed no injuries that would have contributed to his death. The only external finding was a 5/8-inch contusion on the forehead. There were no ocular or cutaneous petechiae. Internal examination was remarkable only for swelling of the brain. No other internal injuries were identified. The cause of death was attributed to asphyxia due to chest compression, and the manner of death was accidental.

Case 3

Following breakfast at a local fast-food restaurant, an 18-month-old white female child and her 2-year-old sister fell asleep on separate couches in the living room of their mobile home. The girls' 19-year-old mother went into her bedroom and also fell asleep. The mother was awakened in the early afternoon by the older child, who was asking for something to drink. The mother went into the kitchen and observed the stove over-turned on the younger girl, with only her legs visible. The mother pulled the child, who appeared to be blue, out from under the stove and ran outside with the child in her arms, screaming for help. A nurse, who happened to be next door, performed cardiopulmonary resuscitation until paramedics arrived and transported the child to a local hospital, where she was subsequently pronounced dead.

The scene investigation was performed by the sheriff's office, who observed a tipped over stove that was unplugged and had its

TABLE 1—Summary of cases.

Case	Age	Race	Sex	Offending Object	Cause of Death
1	17 months	White	Male	Dresser	Asphyxia
2	17 months	Black	Male	Dresser	Asphyxia
3	18 months	White	Female	Stove	Asphyxia
4	2 years	White	Female	Dresser	Asphyxia
5	3 years	White	Male	Television (size unknown)	Blunt thoracoabdominal trauma
6	4 years	Black	Male	27-inch television	Blunt head trauma
7	4 years	White	Male	Lounge chair	Asphyxia and blunt head trauma
8	6 years	Black	Female	27-inch television	Blunt head trauma
9	3 years	White	Female	36-inch television	Blunt head trauma

door slightly open. There were numerous empty beer bottles around the unkempt trailer, and law enforcement also found small baggies of marijuana and cocaine. A doll re-enactment was performed with the mother, and the investigators concluded that the child had been standing on the door of the stove when it tipped over. This resulted in the pinning of the child between the stove and the door to the oven, with her body partially within the oven. The recreation of the stove falling produced a very loud noise that could be heard throughout the trailer and shook the entire trailer. The mother was observed to appear inebriated. She agreed to a drug test, which was positive for cocaine and marijuana. The deceased child's aunt revealed that the child had been removed from the mother's care several months prior to her death after she was found to have bruises including a patterned injury to the face, unexplained burns of her hands, and a fractured elbow and had only recently been returned to the mother.

External examination of the body of the well-developed, well-nourished baby girl revealed small contusions of the forehead, right knee, left shin, and the lumbar region of the back. The skin of the eyelids and the face showed numerous petechial hemorrhages, and a few petechiae were seen on the palpebral and bulbar conjunctivae. The internal examination was remarkable only for pulmonary edema. No internal injuries were identified. The cause of death was attributed to asphyxiation due to mechanical compression of the torso, and the manner of death was accidental.

Discussion

The potential for the accidental suffocation or mechanical asphyxia of infants owing to unsafe infant-sleeping conditions, including the prone sleeping position, compressible sleep surfaces, and bedding and the co-sleeping of infants with adults and/or other children, has been stressed by many investigators in recent years (5). In some studies of infant deaths attributed to sudden infant death syndrome, a disproportionate number of reported cases occurred when the child shared a sleep surface with an adult(s) or older child (5–7). Because the postmortem findings in asphyxial deaths of infants are nonspecific or nonexistent, the determination of the cause and manner of death in such cases necessitates a multidisciplinary investigation involving the law enforcement agency, the medical examiner/coroner's office, child protective services, emergency medical personnel and the child's pediatrician, and, frequently, a doll re-enactment of the scene and circumstances of death.

Once the child reaches the developmental stages of crawling and walking, however, new potential household hazards become paramount. Agran and coworkers (1) emphasized that developmental achievements place a child at risk of specific causes of injury, as the child becomes able to access hazards before developing the cognitive hazard awareness and avoidance skills. Each year, many toddlers die from drowning, fires, poisoning after swallowing unsecured medications or household chemicals, and firearm injuries because of access to weapons in the home (1). Less well recognized is the potential for childhood injuries and/or deaths resulting from the falls, most commonly unwitnessed, of household furniture or domestic appliances on children (<http://www.cpsc.gov/cpscpubs/5004.pdf>).

Bernard and colleagues (2) reported in 1998 that toppling television sets caused significant pediatric morbidity and mortality, reviewing 73 cases that involved falling sets, including 28 deaths, from data of the US Consumer Product Safety Commission over the 7-year period from 1990 to 1996. The mean age of the victims was 36 months, and head injury was the most frequent cause of

death. The authors stressed the importance of safer design and placement of this ubiquitous product. Subsequently, 36 television-tip-over-related deaths and 65 furniture-tip-over deaths were reported to the CPSC from 2000 through 2005 (<http://www.cpsc.gov/cpscpubs/5004.pdf>). Additionally, CPSC estimated that in 2005 alone, at least 3000 children younger than the age of 5 were seen in US hospital emergency rooms because of injuries sustained when a television tipped over. They reported that these deaths usually occur when children climb onto, fall against, or pull themselves up on pieces of furniture or television stands. CPSC included furniture-related tip-overs in its list of "Five Hidden Home Hazards" and issued a warning urging caregivers to take appropriate steps to prevent such tragedies, including verifying the stability of items of furniture and appliances and, for added security, anchoring appropriate items to the floor or wall.

Fatal asphyxial deaths of children past the premobile stage are uncommon. Byard and coworkers (3) identified only six cases of unintentional fatal traumatic asphyxial deaths of children in Adelaide, South Australia, over a 35-year period. Only two of these involved household furniture, one a chest of drawers, and one a table tennis table. However, in a review of deaths caused by traumatic asphyxia in New Mexico, Sklar et al. (4) reported that children under the age of 5 who were crushed under household furniture were among those found at a highest risk of traumatic asphyxia.

In cases of childhood deaths caused by asphyxia, the autopsy findings are generally nonspecific. Most commonly, the only finding is acute visceral congestion (8). Mechanical asphyxia, also termed traumatic asphyxia, occurs when a heavy object or unyielding substance compresses the chest and/or upper abdomen impedes the chest expansion and diaphragmatic lowering necessary for respiration (9). Mechanical asphyxia can also result from compression of the neck. At autopsy, there is usually congestion of the face and upper torso, frequently associated with numerous ocular and facial petechial hemorrhages, sometimes with a sharp demarcation of the congestion and/or petechiae at the line of the junction of the compressed and noncompressed tissues, although these findings are not invariable (5,9,10). No petechiae were seen in two of our five cases in which death was attributed at least in part to an asphyxial cause. Conversely, petechiae are not diagnostic of asphyxia and may be seen in such nonasphyxial causes of death as some types of cardiac death and in individuals with a coagulopathy (10). Petechiae may also occur as a postmortem artifact resulting from hypostasis when a body is in a certain position for a prolonged period after death (9).

Because cases of mechanical asphyxia may have no specific or significant findings at autopsy, the most important information is usually gained from the investigation into the scene and circumstances of the death. Mechanical asphyxia was identified as the cause of death in four of our cases and as a contributing factor in a fifth. The remaining deaths were certified as being caused by blunt trauma. In all cases, the determination of the cause and manner of death relied heavily on the investigation into the scene of death. Case 3 illustrates the importance of a thorough scene investigation in an asphyxial death. Through the use of a doll re-enactment, the investigating law enforcement agency was able not only to determine the exact cause of the child's death but to demonstrate that the toppling over of the stove resulted in noise and shaking of the mobile home that should have alerted the mother. Pursuant to the results of her toxicologic studies that indicated impairment owing to substance abuse, criminal charges were brought against the mother. The investigation into the scene and circumstances of death was equally essential in the cases in which death was attributable

to blunt trauma, as children's physical injuries could easily have been mistaken for intentionally inflicted injuries and the caregivers charged with child abuse.

Although household furniture and appliance tip-overs are uncommon causes of death of young children, these deaths are preventable and can be avoided by proper stabilization of such objects in the residence and by appropriate supervision. The recognition of such hazards is essential in preventing future avoidable deaths and necessitates a multidisciplinary approach to the medicolegal investigating, with correlation of the results of the investigation, including caregivers' statements, with the autopsy findings. As with all childhood deaths where it is suspected that inadequate supervision may be a factor, investigators should consider requesting toxicologic testing of the supervising caregivers as soon after the death is discovered as possible. In addition, a thorough investigation is essential to rule out the possibility of abusive trauma.

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