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CASE REPORT

PATHOLOGY/BIOLOGY

Mary Dudley,[1,2] *M.D., M.S., R.N. and BreAnna M. Chapman,*[1,3,†] *B.S.*

Death of a 6-Year-Old Boy with Mental Retardation: Accident Versus Child Abuse*

ABSTRACT: This case study involved death of a 6-year-old child with a history of mental retardation secondary to meningitis at 11 months, spastic quadriplegia, seizure disorder, and hydrocephaly with a remote ventriculoperitoneal shunt placement and gastric tube feedings. Reportedly, the child was co-sleeping with his mother when she awoke and discovered him lying prone and not breathing on the carpeted floor next to the bed. He was transported to the hospital and died in the emergency room of unknown causes. The medical examiner assumed jurisdiction of the body. The external examination revealed petechial hemorrhages on the neck and face, with patterned linear pressure abrasions on the chest, arms, and face. X-rays revealed leg fractures of different ages. This case emphasizes the importance of coordination of death scene investigation, medical history review, and autopsy results through a forensic team approach to determine the accurate cause and manner of death.

KEYWORDS: forensic science, cerebral palsy, positional asphyxia, multiple fractures, osteopenia, forensic team

This case study involved the death of a 6-year-old child with a history of mental retardation/cerebral palsy (CP) secondary to meningitis at age 11 months, spastic quadriplegia, seizure disorder, and hydrocephaly with a remote ventriculoperitoneal shunt placement, gastric tube feedings, and an internal vagal stimulator. The subject was a 6-year-old male child who was 40 inches in height and weighed 44 pounds. The case was reported to the medical examiner as a suspicious death. Reportedly, the child was co-sleeping with his mother when she awoke and discovered him lying prone and not breathing on the carpeted floor next to her bed. He was transported to the hospital where he failed to respond to resuscitative efforts.

The external examination revealed petechial hemorrhages on the neck and face, along with patterned linear pressure abrasions on the chest, upper arms, chin, and forehead (Fig. 1). The radiographs showed acute fractures of bilateral proximal tibia/fibula and old healing fractures of bilateral distal femur with soft tissue calcification and periosteal reaction as seen on X-ray (Fig. 2). There was a percutaneous endogastric tube in the anterior midline abdomen for tube feeding. There were flexion contractures of the arms and legs. This case study emphasizes the importance of coordination of death scene investigation, medical history review, radiology findings, and autopsy results through a forensic team approach to determine the accurate cause and manner of death.

[1]Jackson County Medical Examiner's Office, 660 East 24th Street, Kansas City, MO 64108.
[2]Department of Clinical Pathology, University of Missouri-Kansas City, 2411 Holmes Street, Kansas City, MO 64108.
[3]Department of Biochemistry, Indiana Wesleyan University, 4201 South Washington Street, Marion, IN 46953.
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†Present address: 15678 South Blackfeather Street, Olathe, KS, 66062.
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Discussion

The following evaluates several of the presenting traits of the 6-year-old boy as discovered by review of medical records, the forensic autopsy, and the forensic team investigation. It was important in this case to evaluate the child's medical conditions, the death scene investigation, and autopsy results to determine the cause and manner of his death.

Cerebral Palsy

CP is a relatively common disorder affecting approximately 2/1000 people. CP is defined as a nonprogressive motor condition, which results from damage or defect in the intrauterine or early developing brain and can cause impediments to development of motor skills along with speech and vision. There are varying types, degrees of severity, and functional abilities of CP with differing etiologies as well. The condition may arise prenatal, perinatal, or postnatal, and the effects range topographically from monoplegia to double hemiplegia and physiologically from spastic, athetoid, ataxic, to tremor—all with differing levels of functionality and limitation. The most severe type of CP is spastic quadriplegia because of the significant abnormality in motor development and the common sequelae of seizures, mental retardation, trouble swallowing, and speech and visual defects (1).

As CP, especially the severe case of spastic quadriplegia, inhibits the motor development of muscles, numerous secondary conditions can arise, including osteopenia, immobilization, necessary tube feeding and leg braces, and complete dependence on the caregiver. According to a study of 139 children with CP (the largest reported evaluation of the bone density of those diagnosed with CP), the

FIG. 1—*Pressure marks of head and chest.*

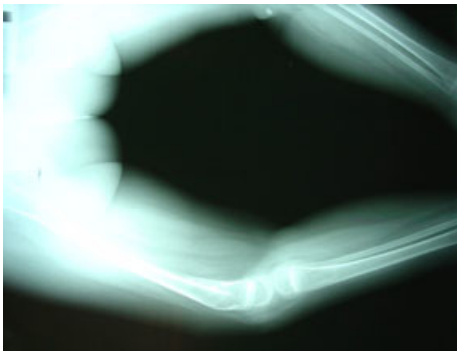

FIG. 2—*X-ray of tibia/fibula and femur.*

quadriplegic group specifically had the greatest probability for low bone mass density (BMD). Tube feedings involved with severe CP may not supply all necessary nutrition, vitamins, and calcium, which combined with anticonvulsant medicine can cause insufficient mineralization and lower bone density. Osteopenia and nonambulation secondary to the CP condition can in turn cause the weakening of bone and loss of BMD, making the patient's bones more susceptible to injuries such as fractures. Because children and young adults with CP often suffer from osteopenia, imbalance, and seizure disorder, these secondary conditions pose a higher propensity for fractures especially fractures of the femur. Also, the nonambulatory state of many children with CP becomes a risk factor for fractures, as reports show that almost 20% of children and adolescents unable to walk had experienced a femur fracture. In Henderson et al.'s (2) previous study of children with spastic quadriplegic CP in 1997, nine fractures were observed over 4 years and 60% of these were femur fractures. Ten of the 43 youths involved in this study had suffered a fracture previously. From the study of 117 subjects (2–19 years of age) with moderate to severe CP presented by Henderson et al. (2) in 2002, osteopenia was observed in the nonambulatory children with CP by the time they were 10 years old. A study by King et al. (3) showed that nonambulatory children and adults with neuromuscular disorders have significantly lower BMD levels. Diminished BMD creates higher risk for nontraumatic or traumatic fractures.

Many patients with the combination of CP and seizure disorder are prescribed anticonvulsants. These have been inversely linked to BMD; thus, the greater the amount of anticonvulsants, the lower the BMD level. Phenobarbital and diphenylhydantoin, both anticonvulsants, have been found to trigger physiological pathways, which produce additional polar metabolites and cause osteopenia. However, newer anticonvulsant medications including carbazepamine, topiramate, and valproic acid have been offered as possible alternatives that will not activate these pathways. King et al. (3) propose a new research study using biphosphates as therapy.

Complications of meningitis have been known to cause CP in young children. In fact, one study clinically reviewed cases of children with meningitis to detect a correlation of meningitis with the development of spastic tetraparesis (synonymous with spastic quadriparesis). In their follow-up of 112 cases of bacterial meningitis, 15.1% had developed CP (4). Meningitis is an acute infection of the meninges, the set of membranes protecting the central nervous system; thus, complications and sequela involving the neural system will plausibly follow. Three main pathogens, *Haemophilus influenzae, Neisseria meningitis,* and *Streptococcus pneumoniae*, cause 80% of bacterial meningitis occurrences. Males are more likely to contract the infection, and *H. influenzae* is the primary organism to infect children from 2 months to 6 years of age (5). Although meningitis can affect people of all ages, 95% of cases affect children from 1 month to 5 years of age. Infants from 1 to 12 months of age are at the highest risk because their immune systems have weaker capacity to fight certain pathogens (6). The long-term ramifications of childhood meningitis include loss of hearing, mental impediments, and cranial nerve defects and affect up to 50% of those who do survive the severe infection as a neonatal or child. Hydrocephalus can occur in children who have survived meningitis may require a cerebrospinal fluid shunt addition (7). Some other long-term complications of meningitis in children include seizures, immobility, osteopenia, and necessary tube feedings. The tube feedings can lead to malnutrition and insufficient vitamin D and calcium intake, which in turn reduces bone absorption and further contributes to osteopenia in children.

Positional Asphyxia

According to Bernard Knight (8), there are five types of asphyxia including mechanical, suffocation, smothering, choking, and traumatic. Mechanical asphyxia also includes the subtype of positional asphyxia. There are numerous external and internal indications of asphyxia. These include petechial hemorrhages, congestion, edema, cyanosis especially of the face, engorgement of the right heart, and fluidity of the blood (8). Petechial hemorrhages of the eye sclera and pressure abrasions on the neck and chest are specifically associated with positional asphyxia. Petechiae appear as pinpoint hemorrhages on the eye sclera, conjunctiva, or skin. Petechial hemorrhages are caused by the mechanism of leaking capillaries because of the hypoxia.

As the name suggests, positional (also postural) asphyxia occurs when the position of the body blocks the airway and compromises the ability to breath. This may occur when the neck is bent in such a way to prevent the passage of air, when the body is completely or partially upside down, and when the head and/or the whole body is wedged. In most cases, the person cannot alter the compromising position because of either a previous injury, drug intoxication, entrapment, or an existing debilitating disease or immobility. Physiologically, anoxia, acidosis, or hypercarbia may actually be the fatal consequences of the initial positional asphyxia. Compression of the neck may be seen as pressure abrasions and can cause internal pressure of the carotid artery, jugular veins, or airway compromise. Pressure of the carotid artery can cause vagus nerve stimulation leading to bradycardia and a fatal arrhythmia. This is especially applicable to those with CP because in some cases, they have particularly precarious autonomic systems (9).

In order for the medical examiner to conclude positional asphyxia as the cause of death, the scene must be thoroughly investigated, ideally before the decedent is moved. Also, any witnesses

with knowledge of the decedent or the death scene should be interviewed for possible clues as to the decedent's potentially fatal position. In a retrospective 10-year study by Brogan et al. (9), the King County and Snohomish County's (State of Washington) medical examiners' death records from 1979 to 1989 were reviewed for the cause of death; it was found that of the 25 deaths ascribed to positional asphyxia, three of 25 or 8% were cases of persons diagnosed with CP. In two of the three cases, the bodies were found at the scene partially suspended out of bed, and in the third case, the head was located between the mattress and headboard. Brogan et al. (9) concluded that because of the significant percentage of CP fatalities caused by positional asphyxia, those with such severe conditions of CP must be at a higher risk for such an uncommon manner of death. Even though children or adolescents with severe CP may be older, they are at the same risk as infants for accidents that are fatal to the immobilized, such as positional asphyxia. Ideally, the surroundings of those with such severe CP ought to be safeguarded against accidents, which may not be a concern in healthy children and young adults of their same age. This discrepancy in accident propensity may be attributed to their deficient motor skills (9).

Multiple Fractures

A child presenting multiple fractures, especially fractures of various ages, bilateral fractures, and complex fractures, strongly suggests nonaccidental trauma in the absence of a history compatible with injuries. In B.G. Brogdon's book, *Forensic Radiology,* he cites Caffey as first indicating the high specificity of child abuse with the presence of numerous fractures of different ages. The various ages of the fractures are evidenced by different levels of healing in conjunction with an incompatible or nonexistent history of trauma (10). In one study of 31 infants who died of child abuse, 29 had at least one fracture with healing reactions; of the total 165 fractures found, 36 were acute (11). Moderate specificity for child abuse would be multiple fractures of different ages especially bilateral fractures. Low specificity for child abuse would be a single linear fracture, which could equivocally have been caused by accidental trauma.

Although children with multiple fractures may have indeed suffered from abuse, certain uncommon medical conditions can cause fractures and appear as nonaccidental trauma-related fractures. Some of these conditions include osteogenesis imperfecta, Menkes syndrome, osteopetrosis, vitamin A toxicity, scurvy, and leukemia. Certain medical interventions such as intraosseous catheters can cause acute fractures, hemorrhaging, and bony defects, which all may appear as nonaccidental trauma. Interestingly, growth spurts in infants, especially under 6 months of age, may cause periosteal reactions symmetrically along bones and give the appearance of previous injury or abuse to the bone that produced bone formations (or periosteal reactions) (12). Because of demineralization secondary to disuse, children with limb paralysis are at greater danger of fractures, even in the absence of rough handling. Investigators must consider the possibility of child abuse in children with a preexisting disease or disability as it has been found that abuse can co-occur with an underlying bone disease and such incapacitated children are actually at a greater risk for abuse (13).

Conclusions

The medico-legal death investigators involved must adopt objective lens to thoroughly evaluate the findings of the scene, autopsy, and medical history of child deaths. In deaths of suspected child abuse victims, the need for this thorough objectivity only increases. In cases of suspected nonaccidental trauma, it is vital to investigate for a complete picture of risk factors for child abuse. Some of the risk factors relevant to this case include situations where a child's mother is a single parent. This magnifies any other stresses because she alone is responsible for the child's care and provision. Also, if the parent is the primary caregiver of a disabled child, the risk of child abuse increases. The greater dependency on the parent's care contributes to stress and can make child abuse more likely. It is essential that investigators examine the possibility of child abuse in the case of a debilitated child because children with such special needs are at an increased risk for child abuse. According to the U.S. Department of Health and Human Services, physical abuse of disabled children is 2.1 times more prevalent than among children without disabilities (14). Also, the financial stress of many medical necessities of a child with disabilities increases the risk for child abuse.

Specific aspects of this case suggest the presence of nonaccidental trauma. The injuries such as the neck, face, and thymus pressure abrasions discovered by autopsy were inconsistent with the initial history. Nonaccidental trauma tends to manifest itself away bony prominences, and according to one study, about 60% of child abuse victims showed trauma to their head, face, or neck (14). The petechial hemorrhages were suggestive of asphyxia, which alone could either be accidental or nonaccidental. The acute and healing fractures of various ages were suggestive of abusive injuries. The long bone femur fractures especially point toward nonaccidental trauma (15). The simple explanation that he rolled off of the bed is a classic trauma explanation (16).

Along with the nonaccidental trauma indicators, there are many factors from this case suggesting accidental trauma. The mother was consistent in her recounting of history and findings. The mother's call for help and transport and appropriate grief reaction to her child's death indicated her concern and care for her son. The fact that there had been no prior Child Protective Services involvement also points toward accidental causes of death.

X-rays obtained at autopsy revealed generalized osteopenia and bilateral acute and chronic fractures to the lower extremities, which were initially suspicious for abuse were determined to be accidental. The fractures included old healing fractures of the distal femurs bilaterally and acute fractures of the proximal tibia bilaterally. Bone marrow studies revealed osteopenia with narrowed bone spicule and decreased mineralization of osteoid consistent with his history of immobility, CP, tube feedings, and anticonvulsant therapy. The remote fractures of the femurs were determined to be consistent with the child's history of osteopenia, leg braces, physical therapy, and seizure disorder. The acute fractures of both proximal tibia were consistent with the intraosseous catheter insertion into osteopenic bone (Fig. 2).

The medical examiner was concerned about finding the cause of the pressure abrasions and petechial hemorrhages suggestive of positional asphyxia and requested that the detective conducts a scene investigation. The police detectives returned to the home to search for any object near the bed on which the child may have fallen on. The scene investigation revealed an intravenous pole with a metal base near his bed used to hang tube feedings; the base consisted of spokes that extended from the center of the pole with a wheel beneath each spoke (Fig. 3). In repositioning the child over the base of the pole in a prone position, the linear horizontal pressure abrasions on the head, chin, and upper chest were noted to be consistent with the dimensions of the base of the pole (Fig. 4). When the child fell out of bed, he landed face down on the base of the IV pole and simply could not move from that position

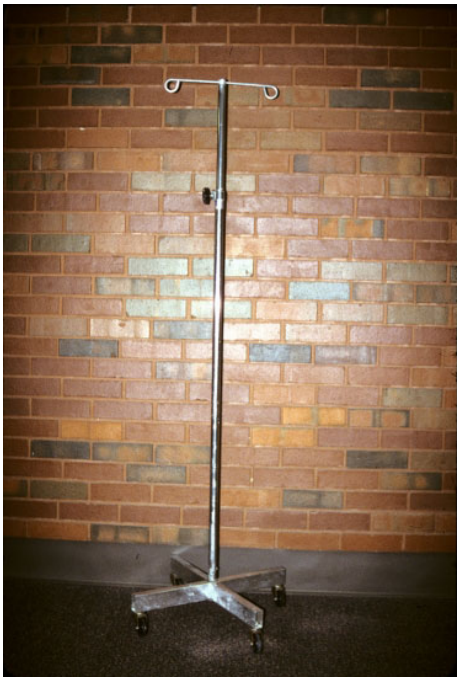

FIG. 3—*Photograph of IV pole.*

FIG. 4—*Photograph of child repositioned on IV pole base.*

because of his quadriplegia. The mother picked up the child from the dark bedroom and had not noticed that he had fallen on any objects in the room.

This case was initially suspicious for nonaccidental trauma because of the finding suggestive of positional asphyxia and multiple fractures of different ages. However, after a thorough review of medical history, hospital records and medical interventions, autopsy findings, and scene investigation, the suspicious injuries were determined to be accidental. The leg fractures were actually chronic, based on the history of having his legs forced into braces causing chronic calcification and thickening of the bone periosteum. There was also a history of aggressive physical therapy and seizure disorder, both contributory to the chronic femur injuries. Osteopenia was secondary to quadriplegia and immobility. Insertion of intraosseous catheters caused iatrogenic acute fractures of both proximal tibias in osteopenic bone. Petechial hemorrhages and pressure marks of the chest matched the IV pole base found at the scene during a scene visit, associated with positional asphyxia. Because of his quadriplegia, he was unable to move himself off of the IV pole base pressing on his airway and compromising his respiratory efforts.

Summary

Thorough investigation of child fatalities emphasizes the importance of the juxtaposition of initial scene investigation and autopsy findings with medical history and follow-up scene investigation and even reconstruction of the scene. Although the child's death initially appeared to be due to nonaccidental trauma, further examination into the medical history and intervention revealed explanations for the suspicious findings. It was vital to the final determination of the cause and manner of death that the forensic team members considered alternative causes of fractures, the medical conditions, the risks of immobility, and the medical intervention contributing to the child's death.

Initially, conflicting information and findings made it difficult to determine the cause and manner of death and required additional information and a complete scene investigation. The collaboration of the scene investigators' discoveries, the medical examiner's autopsy results, and a thorough review of the medical history was essential to the cause and manner of death determination for this case. In view of the child's history of quadriplegia, osteopenia, and medical intervention, the cause of death was ruled as positional asphyxia and the manner deemed as an accident.

From these findings, there are several preventative measures that ought to be considered including creating healthy and safe sleeping environments for children and particularly those with disabilities limiting their movement. For example, the bed ought to be fitted with a safe mattress and bedding to prevent the child or adolescent from being accidentally wedged or smothered while sleeping. Also, newer anticonvulsants and vitamin D supplements should be evaluated further in their effectiveness for decreasing osteopenia and its debilitating effects. Last, medical personnel should take extreme care in inserting intraosseous catheters, because the catheter insertion into osteopenic bones may cause acute fractures, which can be mistakenly diagnosed as nonaccidental trauma.

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Additional information and reprint requests:
Mary Dudley, M.D., M.S., R.N.
Chief Medical Examiner
Jackson County Medical Examiner's Office
660 East 24th Street
Kansas City, MO 64108
E-mail: mdudley@jacksongov.org