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PAPER

PATHOLOGY/BIOLOGY

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A Retrospective Study of the Investigation of Homicidal Childhood Asphyxial Deaths*

ABSTRACT: As one of the leading causes of traumatic deaths in newborns, infants, and young children, there is no anatomic or microscopic feature that is pathognomonic for asphyxial deaths. Instead, pathologists rely on investigation information, including confessions and/or witness statements, and potential evidence at the scene. Twenty cases of homicidal newborn, infant, and young children asphyxial deaths were reviewed, which included death and police investigation reports and autopsy reports, as well as histology slides of lung sections. This series of homicidal asphyxial deaths highlight that, in a vast majority of such cases, the final cause and manner of death rulings are dependent on confession by the perpetrator. Furthermore, this series highlights the possible role of histology to help forensic pathologists better certify asphyxial deaths. Finally, this series emphasizes important investigation points and considerations at autopsy during the investigation of asphyxial deaths in newborns, infants, and young children.

KEYWORDS: forensic science, asphyxial deaths, homicide, newborn, infant, young children, scene investigation, autopsy, histology

Asphyxial deaths, one of the leading causes of violence-related injury deaths in newborns, infants, and young children, present many challenges for forensic pathologists and investigators that require an exhaustive investigation (1). In those cases where lethal injuries are identified at autopsy, the cause of death is often straightforward. However, manner of death determinations may be problematic, requiring careful evaluation of autopsy and scene findings, as well as suspect and witness statements. While external injuries may be present to raise the suspicion of homicidal asphyxia, often these injuries are minimal or absent, thus creating more difficulties when assigning a cause and manner of death. In such cases, the possibility of an asphyxial death with minimal or absent autopsy findings must be considered.

There is no set of autopsy criteria that is pathognomonic for asphyxial deaths, nor are there distinct findings to differentiate between homicidal and accidental deaths. Ultimately, determination of the cause and manner of death in most newborn, infant, and young childhood asphyxial deaths is not possible based on the autopsy findings alone. Rather, the diagnosis is often based on scene investigation, witness statements, and even confessions. Twenty cases of homicidal newborn, infant, and young childhood asphyxial deaths by were reviewed. This series highlights the importance of a confession by the suspect or credible witness statements when assigning manner of death.

Furthermore, in an attempt to identify histologic features that can better aid the forensic pathologist in assigning the cause and manner of death in suspected homicidal asphyxial deaths, routine lung sections taken from newborn, infant, and young children asphyxial deaths were reviewed in order to determine if any histologic criteria exist to help differentiate asphyxial deaths from nonasphyxial deaths, or homicides from accidents.

Materials and Methods

A nonrandom sampling of twenty homicidal asphyxial deaths that occurred in newborns, infants, and young children from multiple offices was collected for evaluation. Unless otherwise noted, the autopsies were performed by board-certified forensic pathologists. Review included death and police investigation reports and autopsy reports. In addition, histology slides of lung sections stained with hematoxylin and eosin (H&E) and Prussian blue stains from each case were reviewed, along with sixteen accidental asphyxial cases, and eighteen nonasphyxial cases (as controls). Cases and controls were blindly assessed by three forensic pathologists. Eight specific lung histologic features were graded with a score from zero to four, based on published criteria (0: absence of lesion; 1: presence of lesion in 1–25%; 2: presence of lesion in 26–50%; 3: presence of lesion in 51–75%; and 4: presence of lesion in 76–100%) (2,3). The eight graded features included hemosiderin-laden macrophages, intra-alveolar hemorrhage, intra-alveolar hyperexpansion, pulmonary edema,

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septal/interstitial hemorrhage, interstitial edema, interstitial emphysema, and alveolar collapse.

Results—Part I

Homicidal Newborn, Infant, and Young Children Asphyxial Death Cases

Case 1

The boyfriend of the mother of a 3-year-old boy called 911 to report that the boy had apparently drowned in a bathtub. The boyfriend claimed to have left the boy unattended for approximately 10 min prior to finding him submerged in the bathtub. Responding police officers found the boyfriend attempting cardiopulmonary resuscitation (CPR). Of note, the police noted the conspicuous absence of water in the bathtub, on the bathroom floor, and in the area where the boy had been placed. Despite resuscitative efforts, the boy died.

Autopsy was significant for rare contusions of the forehead with underlying subscalpular hemorrhage, laceration of the left buccal mucosa, an adult bite mark on the child's perineum, two penile linear abraded contusions, a dilated anus with anorectal mucosal hemorrhages, and multiple small contusions on the upper and lower extremities. The sclerae and conjunctivae had no petechiae. Focal dilated airways with septal rupture were in the lungs microscopically.

Police were notified that the autopsy disclosed evidence of probable sexual abuse, but no anatomic cause of death. Subsequent interview of the boyfriend led to a confession that when the child began to scream as he anally sexually abused the child, he placed a plastic bag over the child's face until he stopped screaming. When the child's body began to "jerk," the child was dropped against the bathtub, at which time the boyfriend reportedly went to get ice for the child. When the boyfriend returned with the ice, the child was not breathing.

Based on the autopsy findings, scene investigation, and confession, the cause of death was "homicidal violence including smothering." The manner of death was homicide.

Case 2

An 8-month-old female infant was found unresponsive on a sofa next to her mother. A call was placed to 911, Emergency Medical Services (EMS) responded and initiated CPR, and the infant was transported to the emergency department, where she was pronounced dead.

Autopsy was significant for slight abrasions on the nasal bridge, nasal tip, mid aspect of the chin, right side of the face, and left thumb. The sclerae and conjunctivae had no petechiae. The oral cavity had no injuries. The pleura, thymus, and epicardium had petechiae. Vascular congestion was seen in the lungs microscopically. No anatomic explanation of death could be ascertained at autopsy.

Police were told that the autopsy did not reveal an anatomic cause of death. Further investigation revealed that the mother had been arrested for abusing the same infant when the infant was 3 months old. At that time, the infant had bruises on her face, and the mother admitted to covering the infant's nose and mouth with her hand in order to stop the infant from crying. The infant was subsequently removed from the mother's care and placed with the father, who did not live with the mother. The mother was diagnosed with postpartum depression. Two days prior to the infant's death, the father returned the infant to her mother.

Subsequent questioning of the mother resulted in a confession in which the mother stated that she "bamboo wrapped" the infant when the infant would not stop crying. Bamboo wrapping is performed by tightly wrapping a child in a blanket so that he or she cannot move and thus stops crying.

Based on the autopsy findings and the investigative information, including the mother's confession, the cause of death was determined to be "suffocation." The manner of death was homicide.

Case 3

Paramedics were called to a home of a 21-year-old woman because she could not get out of bed due to feeling tired. While evaluating the woman, the paramedics found a deceased newborn and placenta within the woman's pants that she was wearing. The woman initially denied that she had been pregnant, and she denied that the newborn had been born alive.

Autopsy demonstrated a normally developed, 36-week gestation size, stillborn versus live born female with no evidence of external or internal injury. The sclerae and conjunctivae had no petechiae. The pleura and epicardium had petechiae. However, autopsy could not determine if the newborn was stillborn or live born.

The next day, the newborn's mother confessed to the police that the newborn had been born alive. Prior to the birth of the placenta, the mother stated that the newborn started to cry. The mother confessed that she pressed her leg down on the newborn until the newborn stopped crying. She then raised her leg, but the newborn began to cry again. She then pressed her leg onto the newborn until it became quiet. During her statement, she said, "I think the baby suffocated from being in my pants and under my leg."

Based on the mother's confession, the cause of death was "suffocation." The manner of death was homicide.

Case 4

A 2-year-old boy was found unresponsive in bed at a homeless shelter by his mother, who had just been with him prior to going outdoors for a cigarette. Shelter workers immediately called 911 and initiated CPR. They noted that the boy had been prone on a pillow and there was bloody appearing, frothy fluid in his mouth. The boy was transported to the emergency department where he died. A younger sibling reportedly died of natural causes 5 months earlier.

Autopsy was significant for rare, crusted abrasions on the skin and rare, superficial, linear, and angled red markings on the buccal mucosa of both cheeks and inner aspect of the right lower lip. A small subscalpular hemorrhage was over the right mastoid process. There were no conjunctival petechiae. The lungs were mottled and markedly congested. Chronic bronchiolitis and bronchitis were in the lungs microscopically. The initial cause and manner of death were undetermined, although the following statement was included in the final autopsy report: "The circumstances surrounding this death, along with the absence of a demonstrable anatomic cause of death, raises concern that this death may have been the result of intentional asphyxia."

Approximately 2-1/2 months after the child's death, the mother confessed to police that she had smothered her son using

a pillow. The autopsy report was amended, and the cause of death was listed as "asphyxia due to smothering." The manner of death was homicide.

The following statement was also included in the amended autopsy report: "The confession raises concern that the decedent's sibling, who also recently died, may have also been killed." See Case 5 for information concerning this sibling's death.

Case 5

A 10-month-old, previously healthy, male infant was found dead by his mother at home. The autopsy, performed by a hospital pathologist, demonstrated no injuries. There were no ocular or facial petechiae. Microscopically, a diffuse, moderate-to-severe, lymphocytic myocarditis was in the heart, and focal airway hyperexpansion, extravasation of blood, and scattered pigment-laden macrophages were in the lungs. The scene investigation revealed nothing to suggest foul play. The cause of death was determined to be "myocarditis," and the manner of death was natural.

Five months later, the decedent's 2-year-old sibling was found dead in bed (see Case 4). After the mother confessed to smothering the older child, she also confessed to smothering the 10-month-old infant.

The autopsy report was amended, and the cause of death was listed as "smothering." The manner of death was deemed homicide. The child had died *with* myocarditis, rather than *from* myocarditis.

Case 6

A 4-month-old male infant was reportedly found unresponsive by his father, who claimed that he had just put him down for a nap approximately 10 min earlier. Family members and neighbors initiated CPR, and EMS was contacted. The infant was transported to the emergency department where all resuscitative efforts failed.

Autopsy was significant for multiple, large facial contusions, small abrasions on the nares and chin, an adult bite mark on the lateral aspect of the left thigh, and multiple contusions and abrasions on both feet. Four distinct areas of subscalpular hemorrhage and a remote, healing, posterior rib fracture were also identified. Focal fibrillary gliosis within the corpus callosum was identified in the brain microscopically, and abundant, hemosiderin-laden macrophages within the pulmonary alveoli associated with patchy, bronchopneumonia was in the lungs microscopically.

Further investigation by police revealed that the father had repeatedly cupped his hands over the infant's mouth and nose while putting him to sleep. This information was verified by multiple witnesses. Witnesses also stated that the father had been seen shaking the infant. Based on these statements, as well as the presence of multiple, nonlethal, acute, and remote injuries, the cause of death was certified as "smothering." The manner of death was homicide.

Case 7

An 8-month-old male infant was reportedly found unresponsive by the boyfriend of the child's mother while the mother was asleep. The boyfriend woke the mother, and EMS was contacted. All resuscitative efforts failed, and the infant was pronounced dead.

Autopsy was significant for: conjunctival petechiae; petechiae of the forehead and upper and lower eyelids; a subtle abraded contusion on the forehead with an underlying subscalpular hemorrhage; mild cerebral edema; subtle, curvilinear, superficial abrasions on the anterior aspect of the neck; and a small contusion on the right side of the chin. An intra-oral examination was unremarkable. The lungs, thymus, and epicardium had petechiae. Focal areas of intra-alveolar hemorrhage, hyperexpanded alveoli, and increased intra-alveolar hemosiderin-laden macrophages were in the lungs microscopically.

Although no anatomic cause of death was identified at autopsy, the presence of the petechiae and external neck injuries caused the forensic pathologist to relate his concern about a possible asphyxial death to the police. A police interview with the boyfriend revealed that the boyfriend had awakened when the infant started to cry in the middle of the night. As he attempted to calm the infant, he placed an adult size pillow on his shoulder and held the infant's face against the pillow until he stopped crying.

Based on the admission of the boyfriend, as well as the subtle autopsy findings, the cause of death in this case was listed as "asphyxia, including smothering." The manner of death was certified as homicide.

Case 8

A 3-year-old girl was found dead on a bed in a motel room by a housekeeper when she arrived to clean the room. No other occupants were in the room. The child's mother, who had checked into the motel room the previous evening, was found several hours later after she had reportedly driven her vehicle into a river. She was uninjured, but "incoherent" and exhibited bizarre behavior. According to investigating officers, she had recently lost a custody dispute with her daughter's father. By court-order, she was allowed a 2-h, unsupervised visitation with the child. During the first visitation, the mother took the girl and never returned. The girl's body was found in the motel the next morning.

Autopsy was significant for very early decomposition and a small contusion on the left side of the forehead. Conjunctival petechiae were absent. Intra-oral examination was negative. There were no intrathoracic petechiae. Microscopic examination revealed a mild tracheobronchitis and focal areas of alveolar hyperinflation.

Scene investigation revealed a large, clear plastic bag on the floor next to the bed. A noncoiled telephone cord was wrapped multiple times around the bag in a position such that if the bag had been over a head, the cord would be wrapped about the neck. Testing of the inside of the bag for saliva was negative; however, the testing did not occur in a timely fashion, as police investigators did not disclose the presence of the bag to the forensic pathologist until approximately 2 months after the autopsy. The mother never admitted to killing the child, but she was admitted to a psychiatric facility for her bizarre behavior.

Based on the autopsy findings, the scene investigation, and the circumstances surrounding the case, the cause of death was ruled "homicidal violence." The autopsy report included a statement that suggested asphyxia by smothering as a possible mechanism of death. The manner of death was homicide.

Case 9

The parents of an 18-year-old female discovered blood in the bathroom of their home. Upon questioning their daughter, they

found that she was the source of the bleeding. The parents took their daughter to the emergency department where the physician concluded that the daughter had recently given birth. Her father went home and discovered the body of a newborn male with a placenta, wrapped in a towel, in a cornfield near their home.

Autopsy was significant for a nondecomposed, nonmacerated, newborn male. No external abnormalities were identified, other than a torn umbilical cord and rare bilateral conjunctival petechiae. Subscalpular hemorrhage and focal subarachnoid and subdural hemorrhage were present, consistent with recent vaginal birth. The lungs, which floated when placed in water, contained multiple petechiae. There was no food or air in the stomach. Microscopic examination showed many areas of hyperexpanded pulmonary alveolar spaces and areas of intra-alveolar extravasated blood. An unremarkable, normal placenta accompanied the body.

The teenage mother, who was obese, had "concealed" the pregnancy from her parents. In the early morning hours, she admitted that she had gone into labor and given birth to a live born boy. She noted that he was moving and breathing. She reportedly placed the newborn next to her in bed, after tearing the umbilical cord. She then confessed that she placed a towel over the newborn's face and held it there for up to 20 min. After the newborn was dead, she wrapped him in a towel, along with the placenta, and threw him into the cornfield near their home.

Based on the mother's confession, and the corroborating autopsy findings, the cause of death was certified as "homicidal violence with asphyxia due to smothering." The manner of death was deemed homicide.

Case 10

A caretaker found a 6-month-old female infant unresponsive and prone on a couch where she had placed the infant 6 h earlier. As she was without a phone, the caretaker took the infant to the infant's mother's house down the street where a resulting altercation between the caregiver and the mother prompted a neighbor to call the police. Police responded to the home and called EMS. EMS arrived at the mother's home and found the infant dead.

Autopsy was significant for multiple contusions on the head with underlying soft tissue hemorrhage. Scattered contusions of the soft tissues of the upper aspect of the back and buttocks, and a fracture of the distal right tibia with associated periosteal hemorrhage were noted.

Microscopic examination of the lungs demonstrated fat emboli, congestion of alveolar capillaries, and occasional scattered lymphoid aggregates within the pulmonary interstitium. The presence of numerous nonlethal injuries was considered suspicious, but no explanation for death could be given using the autopsy findings alone.

The caregiver initially accounted for the facial bruises and leg fracture with a statement that the infant had fallen off of a bed. After further questioning, the caregiver eventually admitted that she had hit the infant to make her stop crying. When this did not stop the infant from crying, she placed a pillow over the infant's face and held it until the infant became quiet. Following this confession, the cause of death was ruled "asphyxia due to smothering." The manner of death was deemed homicide.

Case 11

After leaving her infant and two older children with her boyfriend, a mother returned home from a meeting and found her 8-month-old female infant unresponsive on a mattress with a blanket wrapped around her head. The mother's two other children were still in the house, and the boyfriend was found asleep in a separate room. EMS was notified, and resuscitation was attempted, but death was pronounced at a local emergency room approximately 1 h later.

Autopsy was significant for three contusions on the forehead, three abrasions on the face, a laceration of the upper frenulum, and three contusions on the abdomen and upper extremities. The epicardium and right lung had rare petechiae. Microscopic examination of the lungs demonstrated a bronchocentric mixed interstitial inflammatory cell infiltrate. The original cause and manner of death were undetermined.

Nineteen months later, the decedent's 5-year-old brother confessed to his mother that he knew additional information about the circumstances surrounding the death of his sister. A formal evaluation was performed, and the brother said that he tried to feed his sister but she would not take the bottle. He then awakened the mother's boyfriend who then reportedly hit the infant on the head, covered her up with a sheet, and then lay on top of her. The boyfriend reportedly told the brother not to say anything or he would go to jail. With this new information, along with the findings at autopsy, the cause of death was amended to "asphyxia by suffocation/smothering." The manner of death was listed as homicide.

Case 12

A female infant of a young teenage mother had a history of recurrent hospital admissions for apneic events, for which no definite underlying etiology could be determined. Workup included a clinical forensic medicine consultation, which considered Munchausen syndrome by proxy as a possibility, but this was not proven. Covert video surveillance, for use in ruling out factitious or induced illness in a child by a parent, was not available at the time. One apneic episode was witnessed in hospital by a nurse, without the teenage mother present; however, every other in-hospital apneic event began when only the mother was present with the infant. The infant's condition progressively worsened, requiring hospitalization with a diagnosis of apnea-induced anoxic encephalopathy, and she eventually died.

The autopsy was grossly unremarkable. Microscopic examination of the lungs demonstrated diffuse alveolar damage with hyaline membrane formation, acute bronchopneumonia, multiple foreign body giant cells, and necrotizing bronchiolitis. As a definitive underlying explanation for the apnea episodes could not be determined during life or at autopsy, the cause of death was ruled "anoxic encephalopathy due to repeated infantile apnea of undetermined etiology." The manner of death was ruled undetermined.

Several years following the death, the decedent's mother confessed to her mental health therapist that she had suffocated the infant. Apparently, the infant had been the product of an incestuous relationship, as the infant's mother had been sexually abused by a relative. The mother admitted to repeated acts of intentional suffocation with a soft object, leading to multiple apneic events and progressive hypoxic encephalopathy. The cause and manner of death were amended to convey that the repeated episodes of apnea with resultant anoxic encephalopathy were related to intentional asphyxia. The legal matters were handled in closed proceedings in juvenile court.

Case 13

A 2 1/2-year-old boy was found dead in bed by his father, who had full custody of him. The child, who had a history of

"hyperactivity" and possible autism, was prone, face-down on a pillow, on a standard bed. Autopsy revealed multiple bulbar and conjunctival petechiae, but no definitive cause of death.

Shortly after the autopsy was performed, the child's aunt called the police and stated that she had witnessed the father of the child holding the child's head face-down in a pillow. In light of this new information, the police re-interviewed the father. During the interview, the father confessed to killing the child. Apparently, the father was having a party and wanted the child to go to sleep in the afternoon. The child reportedly continued to run around the residence and was disruptive. The father stated that he eventually took the child to the bedroom and held the boy's head face-down in the pillow until he quit moving. He did not check on the child again until much later in the evening when he found the child dead.

Based on the additional information related to the witness statement and father's confession, the cause of death was ruled "suffocation." The manner of death was listed as homicide.

Cases 14 and 15

Emergency medical services responded to a 911 call at approximately 7:30 AM and found two 3-month-old infants dead in their crib. The infants, one male and one female, were fraternal twins who had been born approximately 3 weeks prematurely and had spent approximately 1 week in the neonatal unit following birth. Because one of them had experienced a few episodes of apnea during their hospital stay, both infants had home apnea monitors; however, the parents reported that the monitors had not been in use when the infants died. Responders became suspicious when they realized that the female infant had well-developed lividity and rigor mortis, compared to her brother, despite their similar body size and clothing.

Autopsies on both infants did not reveal an anatomic cause of death for either infant. However, the female had abrasions around the eyes. In addition, lung microscopy demonstrated mild pulmonary edema and focal atelectasis in the female and focal atelectasis in the male.

As part of the investigation, the apnea monitors were collected from the scene with all available recordings downloaded for evaluation. Despite the parents' claims, the monitors had been in use prior to and during the twins' deaths. The monitors showed that the female had died approximately 3 1/2 h prior to the 911 call, while her brother died shortly before the call was made. When confronted with this information in a subsequent interview, both parents confessed that the father had suffocated the infants by holding pillows over their faces, apparently because the mother and father could no longer stand the "incessant crying." For each case, the cause of death was certified as "suffocation." The manner of death was deemed homicide.

Case 16

A 4-month-old male infant was found unresponsive on a couch by his uncle. EMS responded to a 911 call, but all resuscitative efforts failed. Several hours earlier, the infant's teenage mother had reportedly placed him on the couch for a nap following his feeding. The infant had been born 6 weeks premature. His mother was essentially the only care provider, although she lived at home with her parents and sibling.

Autopsy was significant for extensive areas of cutaneous petechiae involving the right side of the face, from the hairline to the chin, with extension of fine petechiae across the forehead and onto the cheeks bilaterally. Diffuse petechiae were also on the neck and right anterior superior thoracic region, as well as the entire right upper extremity. A small abrasion was on the left nasal ala, and a small red discoloration was on the right anterolateral neck. Pulmonary congestion was noted microscopically.

Subsequent interviews were conducted with the mother and uncle of the infant in order to attempt to ascertain a possible explanation for the presence of the cutaneous petechiae. During the interview with the mother, she confessed to suffocating the child by pressing his back, shoulder, and head into her chest and holding him in that position for several minutes. She claimed to have done this in response to the baby's incessant crying.

Based on the mother's confession and autopsy findings, the cause of death was determined to be "mechanical asphyxia." The manner of death was ruled homicide.

Cases 17, 18, and 19

A mother found her three daughters, ages 17 months, 2 years, and 5 years, dead in her bed. Of note, approximately 5 months earlier, the girls' 2-week-old infant sister had been discovered dead in her day cradle. Based on the autopsy and scene investigation in the earlier case, the cause of death for the infant was related to sudden infant death syndrome. Of further interest, 5 days prior to the 3 girls' deaths, a fire had broken out in the girls' room. A passerby noticed the fire and notified the mother, and everyone escaped without injury. The mother had reportedly been asleep during the event.

Autopsy of the 17-month-old demonstrated rare facial abrasions, a single punctate conjunctival petechia, and multiple abrasions of the lower lip. The thymus, pleura, and epicardium had petechiae. Microscopic examination revealed mild pulmonary edema, pulmonary vascular congestion, and focal atelectasis.

Autopsy of the 2-year-old demonstrated multiple conjunctival petechiae, a single, small facial abrasion, as well as rare, subtle contusions on the legs. Re-examination of the intra-oral mucosa the day after the initial autopsy revealed a small, roughly "V"-shaped abrasion of the inner aspect of the lower lip. The thymus and epicardium had petechiae. Microscopic examination revealed mild pulmonary edema, acute pulmonary congestion, and multifocal areas of atelectasis.

Autopsy of the 5-year-old was significant for multiple conjunctival petechiae and abraded contusions of the maxillary gingival mucosa at the base of the maxillary central incisor. Re-examination of the oral cavity on the day after initial autopsy revealed additional findings, including a subtle abrasion of the inner aspect of the upper lip, multiple, punctate abrasions of the inner aspect of the lower lip, and a small gingival contusion between the right central and lateral mandibular incisors. The epicardium had petechiae. Subpleural pulmonary hemorrhage and submucosal hemorrhages of the epiglottis and larynx were noted. Microscopic examination revealed marked pulmonary vascular congestion, mild pulmonary edema, and focal atelectasis.

The cause and manner of death in each case were undetermined but highly suspicious for asphyxia by suffocation. The mother eventually confessed that she had suffocated her children. The cause of death for each was amended to "asphyxia by suffocation." The manner of death was then deemed homicide.

Case 20

A 6-month-old male infant was found unresponsive in his crib by his mother. The mother called 911 and attempted CPR. EMS

arrived and confirmed the infant's death. The infant was born approximately 6 weeks premature but was otherwise healthy. Of note, the infant's half-sibling (paternal) had died approximately 10 years prior with the cause of death listed as sudden infant death syndrome.

The autopsy was significant for multiple petechiae of the thymus, lungs, and heart. Scene investigation was nonrevealing. The cause and manner of death were each ruled "undetermined."

Approximately 3-1/2 months after the death, the infant's mother provided additional information about the death. In a signed affidavit, she described witnessing the father of the child suffocating the boy with a pillow and comforter. The autopsy findings were subsequently amended such that the cause of death was certified as "homicidal suffocation." The manner of death was homicide.

Please refer to Table 1 for a synopsis of the twenty presented cases.

Results—Part II

Microscopic Comparison of Lung Sections

Three histologic features [presence of hemosiderin-laden macrophages (average scores of 1.17, 0.42, and 0.74 for homicidal, accidental, and control cases, respectively), septal/interstitial edema (0.87, 0.44, and 0.26 for homicidal, accidental, and control cases, respectively) and interstitial emphysema (0.82, 0.42, and 0.57 for homicidal, accidental, and control cases, respectively)] were more prominent in homicidal asphyxia cases compared to accidental and control cases in this pilot study; however, these data are not quite statistically significant between homicidal and accidental cases (p-values of 0.06, 0.06, and 0.08, respectively). Despite this, the reviewers reliably demonstrated increased agreement on these three features. The five remaining histologic features did not demonstrate clear differences between homicidal, accidental, and control cases.

Please refer to Table 2 for a synopsis of the results of the histologic features evaluated in this study.

Discussion

Due to the limited specific findings during an autopsy or investigation, newborn, infant, and young children asphyxial deaths continue to present many challenges to the forensic pathology community. Definitive evidence, scene investigation, and witness statements are needed to correlate with the autopsy findings. Currently, in cases where autopsy findings are negative or inconclusive, the only definitive evidence when assigning homicide as the manner of death is a confession by the suspect or credible witness statements if a confession is not given. If neither a confession nor credible witness statements are given, pathologists and investigators must rely solely on their autopsy and scene findings to best determine the cause and manner of death. Depending on the circumstances and the autopsy findings, it is entirely reasonable and acceptable to include statements within autopsy reports that raise concerns of possible foul play. Furthermore, it is important to recognize that for an infant <1 year old, the differential diagnosis includes cases of sudden infant death syndrome/sudden unexpected death in infancy (SIDS/SUID), as well as possible asphyxia related to unsafe sleep environments. This is in contradistinction to many newborns, as well as young children older than 1 year old, where SIDS/SUID is not a consideration.

Certain autopsy findings may be suggestive of an intentional smothering/suffocation event, including oral and buccal mucosal and facial injuries, frenulum lacerations, and facial and/or conjunctival petechiae. Re-examination for injuries, particularly intra-oral trauma, in the days following the initial autopsy may allow previously unrecognized injuries to be visualized, and previously recognized injuries to be better visualized. Conjunctival and scleral petechiae and/or intrathoracic petechiae do not occur in all cases of homicidal asphyxia, and their presence does not automatically indicate an asphyxial event. For example, in the 20 cases presented, petechiae of scleral, conjunctival, and/or intrathoracic areas were documented in 10 cases (50 percent). Rather, the importance of petechiae can only be understood after a complete autopsy and death investigation has been completed (4). While petechiae cannot be explained by external airway obstruction alone, such as described in cases 7 and 13, the

TABLE 1—*Case summary.*

Case Number	Age	Sex	External Trauma	Internal Trauma	Scleral and/or Conjunctival Petechiae	Thymic, Epicardial, and/or Pleural Petechiae	Confession
1	3 years	Male	Yes	Yes	No	Unknown	Yes
2	8 months	Female	Yes	No	No	Yes	Yes
3	1 day	Female	No	No	No	Yes	Yes
4	2 years	Male	Yes	Yes	No	Unknown	Yes
5	10 months	Male	No	No	No	Unknown	Yes
6	4 months	Male	Yes	Yes	Unknown	Unknown	Yes (by witness)
7	8 months	Male	Yes	Yes	Yes	Yes	Yes
8	3 years	Female	Yes	No	No	No	No
9	1 day	Male	No	Yes (birth)	Yes	Yes	Yes
10	6 months	Female	Yes	Yes	Unknown	Unknown	Yes
11	8 months	Female	Yes	No	Unknown	Yes	Yes (by witness)
12	Unknown	Female	No	No	Unknown	Unknown	Yes
13	2-1/2 years	Male	No	No	Yes	Unknown	Yes
14	3 months	Male	No	No	Unknown	Unknown	Yes
15	3 months	Female	Yes	No	Unknown	Unknown	Yes
16	4 months	Male	Yes	No	Unknown	Unknown	Yes
17	17 months	Female	Yes	No	Yes	Yes	Yes
18	2 years	Female	Yes	No	Yes	Yes	Yes
19	5 years	Female	Yes	Yes	Yes	Yes	Yes
20	6 months	Male	No	No	Unknown	Yes	Yes (by witness)

TABLE 2—*Histologic features summary.*

Histologic Features	Average Graded Features (0–4)		
	Homicidal Asphyxia	Accidental Asphyxia	Control Cases
Hemosiderin-laden macrophages	1.17	0.42	0.74
Intra-alveolar hemorrhage	1.02	1.02	1.35
Septal/Interstitial hemorrhage	0.37	0.21	0.45
Intra-alveolar hyperexpansion	1.03	1	1.02
Interstitial emphysema	0.82	0.42	0.57
Alveolar collapse	0.82	0.83	1.48
Intra-alveolar pulmonary edema	1.38	1.48	1.17
Septal/Interstitial fibrosis	0.87	0.44	0.26

presence of true petechiae suggests that chest compression or some other mode of vascular compromise also likely contributed to the asphyxial death. When an autopsy fails to disclose a cause of death, but there is unexplained trauma present, including healing trauma of varying ages, investigators and pathologists should be especially suspicious that a possible asphyxial event may have occurred.

It is common that the autopsy alone may not identify the cause of death in asphyxial deaths. Therefore, death scene investigation is paramount. While the death scene investigation in all cases of possible newborn, infant, and young children asphyxial deaths should include thorough documentation of the scene, including a doll re-enactment, special attention should be placed on any possible items at the scene that may provide further insight into the cause and manner of death, such as evaluating baby monitors and checking the scene to ensure the reported circumstances surrounding the death are possible. In the presented cases, suspicion of foul play was heightened in case 8 because of the plastic bag with telephone cord at the scene, and in cases 14 and 15 when, despite the parents' claims that the apnea monitors were not in use, the apnea monitors were in fact working properly and demonstrated the female infant had died approximately 3-1/2 h prior to a call to 911 was made.

During the scene investigation and subsequent investigation, special attention needs to be placed on the interviews of everyone who was present during the death, as well as individuals who can provide additional information regarding past behavior of individuals present during the death. Some authors note that although extensive questioning may be perceived as insensitive, it is imperative that thorough interviews are performed as soon as possible following a death. The authors further state that unless the truth is being withheld, individuals being interviewed are more likely to be forthcoming with information regarding the circumstances around the death. In addition, while honesty from the interviewees can be difficult to assess, conducting multiple interviews, if possible, can lessen or heighten the suspicion of honesty based on whether or not the circumstances of the death are conveyed in a similar fashion from person to person. If necessary, according to some authors, law enforcement involvement or even a polygraph test may be helpful (5). Occasionally, as was exemplified in several cases presented, multiple follow-up interviews, sometimes even years later, are needed for the perpetrator to admit to his or her homicidal action.

There have been numerous documented cases of false confessions given either by innocent people or other individuals at the death scene. While there is no specific cause of false confessions or false statements, one author suggests that obtaining the confession during an interview on electronic recording can provide an objective record of the confession. Factors such as interview style, suspect levels of anxiety, and age have been documented as risk factors that lead to false confessions (6). However, every case must be evaluated on its own merits, and correlated with autopsy and scene findings. Of the 20 cases presented, 16 rulings of homicide were made only after a confession by the perpetrator, with some of these cases having corroborating witness statements. Three rulings of homicide were based on witness statements without a confession from the perpetrator. Only one ruling of homicide was made without a perpetrator confession or witness statement.

Most of the presented cases were those of filicide, where the newborn, infant, or young child was killed by his or her parent. There are numerous subtypes of filicide that can be classified by motives and causes, and include altruism, euthanasia, acute psychosis, postpartum mental disorder, unwanted child, unwanted pregnancy, angry impulse, spouse revenge, sexual abuse, Munchausen by proxy, violent older child, negligence and neglect, sadism and punishment, drug and alcohol abuse, seizure disorder, and innocent bystander (7). Two of the presented cases fell under the subtype unwanted pregnancy, or neonaticide, where the newborn was killed within the first 24 h after birth (8). Authors note that what leads an individual, most commonly the mother, to perform neonaticide is not clearly understood, but reported risk factors may include lack of resources, young age of the mother, and emotional dissociation. However, these risk factors are not present in all cases of neonaticide (9).

A sizeable number of newborn, infant, and young children deaths have no identifiable anatomic explanation for death at autopsy. When an identifiable gross or microscopic explanation for death is discovered, it frequently provides a sense of reassurance to the forensic pathologist, as it is presumed that *the* cause of death has been identified. However, it is important to note that newborns, infants, and young children can die *with an* underlying, otherwise potentially lethal natural disease, and not necessarily *from* it. This is exemplified by case 5 (infant with myocarditis), wherein the mother confessed to having asphyxiated the infant.

Recently, the idea of reducing cognitive bias ("contextual bias" or "human factors") by eliminating scientists' knowledge of contextual details surrounding a case, to keep the investigation from being hindered by preconceived notions of the investigator, has been lauded as a necessary change (10–13). For many forensic science disciplines, this goal is reasonable; however, in the case of forensic pathology, eliminating *all* so-called cognitive bias is contrary to the practice of good medicine (14). Without knowing many of the details surrounding a case, forensic pathologists cannot perform their job to the best of their ability. There are certain cases where autopsy findings alone are not sufficient to provide enough information to determine a cause and manner of death. For some of these cases, additional scene and investigative information allow such determinations to occur. The present case series highlights this reality. Without valuable information obtained from ancillary investigations, including details provided via interviews and confessions, these homicides would not have been identified.

Microscopically, the results of the eight histologic features described here prompt the need for further evaluation and comparison in a larger cohort to see if the presence of these specific features can help forensic pathologists when assigning the cause and manner of death. There currently is no histologic feature that is specific for asphyxial deaths. However, studies suggest that a semiquantitative analysis of lungs microscopically, as was performed in this series, can help support asphyxia as a cause of death (2,3). Perhaps further studies are needed to determine if

particular autopsy techniques, such as inflating the lungs with formalin before cutting sections to be submitted for histologic evaluation, can help forensic pathologists better certify asphyxial deaths.

In summary, as one of the leading causes of traumatic deaths in newborns, infants, and young children, there is no anatomic or microscopic feature that is pathognomonic for an asphyxial death. Instead, pathologists rely on investigation information, including confessions and/or witness statements, and potential evidence at the scene. It is clear from this series of homicidal asphyxial deaths that, in a vast majority of such cases, the final cause and manner of death rulings are dependent on confession by the perpetrator. Without a confession or other definite indicators of asphyxia, ruling these cases as having an undetermined cause and undetermined manner is acceptable. Including statements of concern regarding the possibility of asphyxial homicide in such instances is also acceptable, depending on the case. Important investigative points in these cases include the following: (i) Scene investigation, with doll re-enactment if possible, is absolutely necessary; (ii) Interviewing care providers (and others) must occur; (iii) Re-interviewing care providers (and others) is often necessary; (iv) Evaluation of various devices (apnea monitors, surveillance devices, etc.) may provide useful information; (v) When a case is finalized, it is important to remain open to obtaining additional information at a later date, with possible re-evaluation of the case and amending of the report and death certificate. Important considerations at autopsy include the following: (i) Noting the presence of subtle injuries, including petechiae, is not pathognomonic for asphyxia but may be very important in leading to further investigation and interviews; (ii) Careful examination of the face, neck, conjunctivae, and intra-oral structures is especially important in newborn, infant, and young children autopsies; (iii) Forensic pathologists should consider holding bodies overnight following autopsy, for re-examination for subtle injuries; (iv) Histologic examination of the lungs for various features may provide additional important information regarding the evaluation of these cases; (v) Further research into these histologic lung findings, using larger cohorts of cases, should be undertaken.

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