An Approach to the Classification of Apparent Asphyxial Infant Deaths

Evan W. Matshes, Emma O. Lew

ABSTRACT

Recent evidence indicates that with thorough, high quality death investigations and autopsies, forensic pathologists have recognized that many unexpected infant deaths are, in fact, asphyxial in nature. With this recognition has come a commensurate decrease in, and in some cases, abolition of, the label “sudden infant death syndrome” (SIDS). Current controversies often pertain to how and why some infant deaths are determined to be asphyxial in nature and whether or not apparent asphyxial circumstances are risk factors for SIDS, or rather, harbingers of asphyxial deaths. In an effort to sidestep these controversies, some forensic pathologists elected to instead use the noncommittal label “sudden unexpected infant death” (SUID), leading to the unfortunate consequence of SUID – like SIDS – gaining notoriety as an actual disease that could be diagnosed, studied, and ultimately cured. Although it is not possible to provide death certification guidance for every conceivable type of unexpected infant death, we recognize and propose a simple classification system for overarching themes that cover the vast majority of cases where infants die suddenly and unexpectedly. *Acad Forensic Pathol.* 2017 7(2): 200-211

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INTRODUCTION

Over the past 25 or so years, diagnostic use of the label sudden infant death syndrome (SIDS) has decreased at varying rates across death investigation centers in the United States and Canada. Reasons for this diagnostic shift are varied and include 1) recognition that SIDS is not a single unified entity, 2) acceptance that accidental asphyxial events are not rare and are heavily influenced by the infant's sleep environment, 3) improvements in the quality of death scene investigations, 4) enhancement in the thoroughness and thoughtfulness of pediatric forensic autopsies, and 5) an improved understanding of the myriad of circumstances that may lead to an infant's accidental demise at home. The sum total of these realities is that practitioners are able to more accurately recognize and diagnose asphyxial events and deaths due to natural disease, resulting in vastly fewer infant deaths being unexplained (or apparently resulting from "SIDS").

The decision of many forensic pathologists to eliminate the SIDS label from their diagnostic lexicon has not come without controversy, with some clinicians going so far as to suggest that the clock has turned back in pediatric forensic pathology, and that the resultant *"diagnostic shift cannot help but have a profound effect on the affected families as well as dampen the enthusiasm for basic scientific research"* (1). Fundamental to such an argument is the notion that SIDS is, in fact, a disease that can be diagnosed, studied, and ultimately cured. Such a thesis is predicated upon the idea that *intrinsic* pathophysiologic derangements underpin the demise of these infants, and that certain *extrinsic* elements such as the sleep environment serve not as risk factors for accidental asphyxial death, but rather, as risk factors for SIDS itself.

Ideological clashes explain the controversies that often arise when forensic pathologists from different institutions debate the cause and manner of an unexpected infant death. Some institutional cultures and practitioner styles involve deeply rooted hesitations at labeling infant deaths as asphyxial in nature. A

reticence at implying parental blame is sometimes cited by pathologists committed to using the SIDS label, which, when used synonymously with "crib death," imparts no individual responsibility for the death.

As conflict grew amongst forensic pathologists and between forensic pathologists and clinicians, researchers, and others, imaginative and elaborate systems for subclassifying SIDS deaths were proposed and published (2), but deployed into American forensic pathology practice with limited impact on the understanding and classification of unexpected infant demise. Such systems stratified infant deaths by risk factors; interestingly, an infant death could still be labeled as due to SIDS ("Category II SIDS") when *"mechanical asphyxia or suffocation caused by overlaying [could not be] determined with certainty"* (2).

Further attempts to clarify diagnostic dilemmas led to the subsequent introduction of the term sudden unexplained infant death (SUID), a label that may have inadvertently brought further confusion to the forensic pathology community. The National Association of Medical Examiners (NAME) Ad Hoc Committee on Sudden Unexplained Infant Deaths defined SUID as:

...[applying] to the death of an infant less than 1 year of age, in which investigation, autopsy, medical history review, and appropriate laboratory testing fails to identify a specific cause of death. SUID includes cases that meet the definition of sudden infant death syndrome (3).

This overarching, nondescript, noncommittal label fundamentally enabled some forensic pathologists to select a pathway that was intermediary between the controversial concepts of SIDS and "infant asphyxia" whilst imparting the appearance of definitive selection of "a" cause of death. With the power of retrospect, the SUID label very rapidly grew into the type of "wastebasket" diagnosis that SIDS was criticized for evolving into. In fact, many infant forensic autopsy reports can be found which bear the concluding sentence, *"John Doe, a X-month-old infant died of sudden unexpected infant death (SUID)."* Like SIDS, for

some pathologists and clinicians, SUID evolved from its origin as a classification system into a lethal disease.

When a system of death investigation 1) embraces a culture of “truth-seeking,” such as the one advocated by Justice Goudge of the Inquiry into Pediatric Forensic Pathology in Ontario (4), 2) employs expert level infant death scene investigations including the use of doll reenactments (5, 6), and 3) demands the performance of excellent pediatric forensic autopsies (5), some infant deaths become explainable. More complex, and less obviously explained deaths – the “gray zone” cases – form the bulk of the medical examiner’s routine pediatric forensic pathology workload.

DISCUSSION

Core Categorizations

Fundamentally speaking, infants die naturally or non-naturally. When an infant death is unnatural, it is because of external influences that were intentionally or unintentionally inflicted upon the child (**Figure 1**). Obviously, the circumstances of some infant deaths cannot be fully delineated, and consequently, forensic pathologists will choose an “undetermined” manner of death. Although the designation “undetermined” is unpalatable to a variety of stakeholders in the criminal and civil justice systems, public health, and the general public, after a full investigation, it can be an

FIGURE 1: Fundamental categorization of infant deaths in the forensic setting.

honest representation of the state and strength of the evidence in a given case. For the purposes of simplifying this discussion, cases of alleged inflicted injuries are eliminated from this paper, and instead, the classification scheme is focused on those infants who die suddenly and unexpectedly and whose cause of death differential diagnosis includes natural disease(s) and mechanical asphyxia. In general, we advocate for the approach promulgated by Nashelsky and Pinckard (7), which we summarize as offering a cause and manner of death *when one knows* the cause and manner of death, and offering an undetermined cause and manner of death when one *does not know* the cause and manner of death. Put another way, we advocate that the labels SIDS and SUID should not be used as causes of death in forensic pathology practice.

When faced with infant deaths in day-to-day casework, forensic pathologists may realize that few cases are straightforward. Deaths that are apparently self-solving may, in fact, be proven to be just that – only *apparently* self-solving. Thorough investigations and studies may reveal findings widely disparate from initial impressions. To that end, in reality, unexpected infant deaths exist on a spectrum between those that are *definitely natural* and those that are *definitely nonnatural* (Figure 2), with many cases falling somewhere between the two diagnostic extremes.

As previously mentioned, environmental risk factors for asphyxia are of paramount consideration during all aspects of unexpected infant death investigation.

Defining a “Safe” Sleep Environment and an Optimal Developmental Environment

Some individuals regard asphyxial circumstances as mere risk factors for SIDS, while others believe that asphyxiating environments can directly cause death. At least partially in recognition of the threat some sleep circumstances can impart on life, in 1992 the American Academy of Pediatrics (AAP) Task Force published a statement on infant positioning and SIDS (8). The Academy recommended that healthy infants, when being put down for sleep, be positioned on their side or back based on careful evaluation of existing data indicating an association between SIDS and prone sleeping position for infants. Two years later, the AAP Task Force, chaired by John Kattwinkel, reiterated their recommendations, which strongly endorsed the practice of placing healthy infants on their sides or back when putting them down to sleep, and now also recommended that soft surfaces and gas-trapping objects be avoided in an infant’s sleeping environment (9). A report by Willinger, which summarized the findings of a meeting held by the National Institute of Child Health and Human Development (NICHD) with cosponsorship from the National Institute on

FIGURE 2: Unexpected infant death spectrum.

Deafness and Other Communication Disorders, the National Center for Health Statistics, and the Centers for Disease Control and Prevention (CDC), was published in 1994 (10). This meeting was held to review information regarding trends in infant mortality and the effects of public health interventions overseas to prevent SIDS, review preliminary data on SIDS and prone sleep position in the United States, and discuss how the information could be used to guide further activities in the United States. Substantially more information had become available since 1992 from countries that had advocated side or back sleeping for infants. After examining the evidence provided that showed a large, sustained decrease in the incidence of SIDS concomitant with similar decline in the proportion of infants sleeping prone, the assembled experts were of the overwhelming opinion that greater effort be made to reach parents with the AAP's recommendation that healthy infants, when being put down to sleep, be positioned on their side or back (10). Thus began the "Back to Sleep" campaign in 1994 by the NICHD, the US Department of Health and Human Services Child Care Bureau and Maternal and Child Health Bureau, and AAP (11). In 1996, the AAP updated the policy on infant positioning, modifying their original recommendations to say that a supine position confers the lowest risk and is the preferred sleeping position (12). A side sleeping position was said to also significantly lower the risk compared to a prone position, and caregivers were advised to bring the dependent arm forward to lessen the likelihood of

rolling into a prone position when placing an infant on its side (12).

The AAP continued to refine their recommendations on infant sleep position and added recommendations for safe infant sleeping environments in 2000 (13). At that time, the task force had ten recommendations intended for sleeping infants (**Table 1**).

In 2005, on the basis of new evidence, the AAP changed its recommendation and no longer recognized side sleeping as a reasonable alternative to fully supine sleeping (14). Other changes to the recommendations in 2005 were the use of a firm sleep surface, avoiding smoking during pregnancy and infant exposure to second hand smoke, and offering a pacifier at nap and bed times (14).

In 2011, the AAP expanded its recommendations from focusing only on SIDS to focusing on a safe sleep environment that can reduce the risk of all sleep-related infant deaths, including SIDS (15, 16). In their policy statement they sorted their recommendations into three levels, A-level, B-level, and C-level (**Table 2**), based on the US Preventive Services Task Force levels of recommendation. A-level recommendations are those for which there is good and consistent scientific evidence; B-level recommendations are only supported by limited or inconsistent scientific evidence, and C-level recommendations are based primarily on consensus and expert opinion (15).

Table 1: American Academy of Pediatrics Recommendations For Safe Infant Sleeping Environments, 2000 (13)

Infants should be placed for sleep in a nonprone position
A crib that conforms to the safety standards of the Consumer Product Safety Commission and the ASTM (formerly the American Society for Testing and Materials) is a desirable sleeping environment for infants
Infants should not be put to sleep on waterbeds, sofas, soft mattresses, or other soft surfaces
Soft materials should be avoided in the infant's sleeping environment (e.g., pillows, quilts, comforters, sheepskins, stuffed toys)
Bed sharing may be hazardous under certain conditions
Overheating should be avoided
To help prevent plagiocephaly, a certain amount of tummy time while the infant is awake is recommended
Devices that have been developed to maintain sleep position or to reduce the risk of rebreathing are not recommended
Electronic respiratory and cardiac monitors are not recommended
The national campaign for reducing prone sleeping ("Back to Sleep") should continue and be expanded to emphasize the safe characteristics of the sleeping environment

In 2014, the “Safe to Sleep” (formerly known as “Back to Sleep”) campaign released several pamphlets for parents outlining these important recommendations and illustrating what a safe sleep environment looks like (17, 18).

In 2016, the AAP published its latest recommendations on safe sleep guidelines with expanded recommendations for infant sleep location, skin-to-skin care for newborn infants, bedside and in-bed sleepers, sleeping on couches/armchairs and in sitting devices, and use of soft bedding after four months of age (19, 20). There are now 19 recommendations listed that are intended

for all who care for infants (**Table 3**), although the last four recommendations are directed toward health policy makers, researchers, and professionals who work on behalf of infants (19). All of these recommendations for sleep position and the sleep environment, unless otherwise specified, are for the first year after birth.

A safe sleep environment continues to be the mainstay of risk reduction for sudden infant death (21). These external factors are highly controllable, and thus modifiable, unlike the innate anatomic and pathophysiologic features of infancy, which can only be observed and respected. Bed sharing is an important risk factor

Table 2: American Academy of Pediatrics Recommendations For Safe Infant Sleeping Environments, 2011 (15, 16)

A-Level Recommendations
Supine sleep for every sleep
Use of a firm sleep surface
Room sharing without bed sharing
Keep soft objects and loose bedding out of the crib
Pregnant women should receive regular prenatal care
Avoid smoke exposure during pregnancy and after birth
Avoid alcohol and illicit drug use during pregnancy and after birth
Breastfeeding is recommended
Consider offering a pacifier at nap time and bedtime
Avoid overheating
Do not use home cardiorespiratory monitors as a strategy for reducing the risk of sudden infant death syndrome (SIDS)
Expand the national campaign to reduce the risks of SIDS to include a major focus on the safe sleep environment and ways to reduce the risks of all sleep-related infant deaths, including SIDS, suffocation, and other accidental deaths; pediatricians, family physicians, and other primary care providers should actively participate in this campaign
B-Level Recommendations
Infants should be immunized in accordance with recommendations of the American Academy of Pediatrics and the Centers for Disease Control and Prevention
Commercial devices marketed to reduce the risk of SIDS should be avoided
Supervised, awake tummy time is recommended to facilitate development and to minimize development of positional plagiocephaly
C-Level Recommendations
Healthcare professionals, staff in newborn nurseries and neonatal intensive care units, and child care providers should endorse the SIDS risk-reduction recommendations from birth
Media and manufacturers should follow safe sleep guidelines in their messaging and advertising
Research and surveillance on the risk factors, causes, and pathophysiological mechanisms of SIDS and other sleep-related infant deaths should be continued

for infants under four months old (19, 20). Particularly dangerous situations involve: bed sharing with a current smoker; bed sharing with someone who is impaired in their alertness or ability to arouse, either because of fatigue or from medications, alcohol, or drugs; bed sharing with anyone who is not the infant's parent (this includes siblings); and bed sharing on soft surfaces such as water beds, couches, armchairs, or with soft bedding accessories such as pillows and blankets (19, 20). A summary of an "idealized" safe sleep environment for an infant is in **Table 4**.

Anatomic and Pathophysiologic Features of Infancy That Increase the Risk of Accidental Asphyxiation

The risk of accidental asphyxiation is not merely theoretical, and the forensic pathologist is cautioned to embrace careful investigations that facilitate recognition and documentation of all external threats to the infant's life, including those that are asphyxial in nature. Pasquale-Styles et al. conducted a study at the Wayne County Medical Examiner Office in Detroit,

Table 3: American Academy of Pediatrics Recommendations For Safe Infant Sleeping Environments, 2016 (19, 20)

A-Level Recommendations
Back to sleep for every sleep
Side sleeping is not safe and is not recommended
Use a firm sleep surface such as a crib, bassinet, portable crib, or play yard that conforms to the safety standards of the Consumer Product Safety Commission
Couches and armchairs are extremely dangerous places, predisposing infants to a high risk for entrapment, wedging and overlay
Breastfeeding as much as possible and for as long as possible is recommended
Room sharing with the infant on a separate sleep surface is recommended ideally for the first year, but at least for the first six months
Keep soft objects and loose bedding (including pillows, quilts, comforters, bumper pads, and sheepskins) away from the infant's sleep area, and products designed to make the sleep surface softer should not be used
Consider offering a pacifier at naptime and bedtime, but do not attach stuffed toys or strings to the pacifier
Avoid smoke exposure during pregnancy and after birth
Avoid alcohol and illicit drug use during pregnancy and after birth
Avoid overheating and head covering in infants
Pregnant women should seek and obtain regular prenatal care
Infants should be immunized in accordance with American Academy of Pediatrics and Centers for Disease Control and Prevention recommendations
Do not use home cardiorespiratory monitors as a strategy to reduce the risk of sudden infant death syndrome (SIDS)
Health care providers, staff in newborn nurseries and neonatal intensive care units, and child care providers should endorse and model the SIDS risk-reduction recommendations from birth
Media and manufacturers should follow safe sleep guidelines in their messaging and advertising
Continue the "Safe to Sleep" campaign, focusing on ways to reduce the risk of all sleep-related infant deaths, including SIDS, suffocation, and other unintentional deaths
Pediatricians and other primary care providers should actively participate in this campaign
B-Level Recommendations
Avoid the use of commercial devices that are inconsistent with safe sleep recommendations
Provide supervised, awake tummy time to facilitate development and to minimize development of positional plagiocephaly
C-Level Recommendations
Continued research and surveillance on the risk factors, causes, and pathophysiologic mechanisms of SIDS and other sleep-related infant deaths, with the ultimate goal of eliminating these deaths entirely
There is no evidence to recommend swaddling as a strategy to reduce the risk of SIDS

Michigan, from 2001 to 2004 and reviewed the death scene investigations to assess the potential risk factors for asphyxia in 209 sudden unexpected infant deaths (22). Of the 209 infant deaths investigated, potential risk factors for asphyxia were identified in 178; if those infants who were witnessed overlays, entrapments, strangulations, and/or had known blocked noses and mouths, or covered heads were considered, then 108 infants died of asphyxia. Infants found in the prone position, with the face down and nose and mouth obstructed at the time of discovery, accounted for 64 of the cases.

The pathologic findings of asphyxia in infancy are often minimal, making the diagnosis of infant asphyxia extremely difficult when autopsy findings are considered in a vacuum of case investigative data (23). Determination of the manner of death often relies more on an assessment of the death scene and sleeping environment than on postmortem dissections alone (24). Widely accepted causes of suffocation include: covering of the mouth and nose with an occlusive material; wedging of the head, with mouth and nose pressed into bedding; and rebreathing of expired air (25, 26). Other dangers for accidental infant asphyxia include overlaying, wedging, and prone sleeping, because of the risk of smothering.

Soft bedding and bolsters create an unsafe sleeping environment by imposing a risk for asphyxiation. Although infants may be able to roll over by themselves, they may be unable to do so with the added handicap of a pliable pillow or deep trough formed by

soft bedding (23). Combrinck et al. report a case of a 5-month-old infant boy who was found face down and unresponsive in a portable cot with a sagging canvas base, exacerbated by a soft foam mattress, two rolled bolsters, and layers of soft bedding (23). In this case, asphyxia resulted from external airway obstruction due to covering of the mouth and face by the soft bedding; rebreathing of exhaled air may have contributed.

Bedding has been implicated as a mechanism resulting in rebreathing suffocation in cases of accidental infant asphyxia (27). Hypercarbia and hypoxia can potentially result when infants resting in the prone position or lying with soft bedding may rebreathe exhaled carbon dioxide (21). Kemp et al. conducted a study on unintentional suffocation by rebreathing, using both a mechanical and a rabbit model to recreate the respiratory microenvironment around the nose and mouth to simulate when an infant is found dead in the prone position with the face straight down (26). The bedding from seven of these cases where infants died with their faces downward and covered by the bedding was obtained for study and was found to have low resistance to airflow, causing considerable rebreathing that was lethal to the rabbits in five of seven cases (26). The authors conclude that items of bedding in common use are capable of causing lethal rebreathing by infants in the prone position whose nose and mouth become covered. Soft and malleable bedding may seal an infant's face within a dangerous microenvironment (28). In another study, Kemp et al. used a technique to measure and compare bedding physical properties by examining the softness, mallea-

Table 4: Idealized "Safe" Sleep Environment For Infants

Supine sleep position only
Sleep in a proper crib, bassinet, or "play yard"
Firm mattress fitted tightly to the edges of the crib
Room sharing with adult caregiver
No bed sharing
No soft objects in the crib
No loose bedding in the crib
Take measures to avoid overheating
Consider use of a pacifier during naps or sleep

bility, and limitation of carbon dioxide dispersal as an indirect estimate of porosity (28). The actual bedding or identical bedding from the death scene of infants who were found face down and whose death was attributed to SIDS was studied. It was found that this bedding limited carbon dioxide dispersal to a greater degree than conventional bedding. This observation, coupled with studies of living infants, suggests that softer, porous forms of bedding are more conducive to fatal rebreathing in prone infants who adopt a face-down posture (28). Softer bedding tends to form a seal around the face and thus causes passage of the expired air across a larger area of contact with the face and into the bedding rather than into the ambient air over the infant's head, a situation which favors rebreathing (28). The potential for thermal stress is also increased with the use of soft, thick bedding (28).

Firm bedding is not completely safe for prone sleeping infants either, as firm bedding may be more likely than soft bedding to cause airway occlusion by nasal compression or repositioning of the mandible in prone-sleeping infants (26, 28, 29). Facial pressure, which is more likely to occur in the prone position, can precipitate the posterior displacement of the mandible with resultant obstruction of the narrow, relatively vulnerable, pharyngeal airway of the infant (8). In 1975, Tonkin postulated that airway obstruction at the posterior pharynx during muscle relaxation that occurs during REM sleep, facilitated by a hypermobile mandible in infancy, might lead to hypoxia, cardiac arrest, and death (30). A hypermobile mandible is vulnerable to displacement by pressure from the infant's own head weight on the mattress, by the infant's own hands and arms, or by tight bedclothes (30). This theory remains a hypothetical mechanism, however, as it cannot be tested (29).

Other dangers for accidental asphyxia from unsafe sleep environments include wedging/entrapment and positional asphyxia when infants slide into gaps between mattresses and cot sides or between beds and walls, particularly in bed sharing situations (24, 31). A lethal restriction of thoracic wall movement caused by compression of the chest may occur when an infant is wedged between two solid objects or with overlaying,

when a larger person lies over the infant (24). Risk factors for parental overlaying include obesity and sedative or alcohol consumption (24, 32). A study by Hayman et al. reviewed accidental suffocation deaths of infants less than one year of age in New Zealand between 2002 and 2009 (31). Forty-eight deaths due to accidental suffocation were found to have occurred during this time frame, 30 of which were due to overlay, and 18 due to wedging. Of these 48, more than two thirds (n=34) were in a bed sharing situation (31). Overlaying deaths occurred in bed sharing situations involving siblings, parents, and mothers while breastfeeding. Wedging deaths involved infants wedged between a sleeping surface and bedding, wall, broken cot, or couch and sofa cushions (31).

An Approach to Classifying Unexpected Infant Deaths

“Definite” Natural and Nonnatural Infant Deaths

A truth-seeking paradigm that recognizes that “children are not just small adults” is a cautionary reminder for all forensic pathologists who investigate unexpected infant deaths. When infant cases are approached as “undifferentiated” in nature from the outset (hence minimizing bias), it will allow for the development of a more robust dataset for interrogation. Within such an information-rich environment, pathologists should feel empowered to make accurate and defensible diagnoses, given the facts and evidence. An approach to archetypical examples is included in **Table 5**.

Consider the example of a previously healthy infant who is found dead, supine in a proper crib devoid of toys and other soft items, and whose environment is free of toxins and excessive heat or cold. If the autopsy demonstrates convincing lymphocytic myocarditis, in the absence of other significant pathologic alterations, and noncontributory toxicology results, the diagnosis of cause and manner of death appears straightforward as lymphocytic myocarditis. Similarly, a previously healthy infant who is found dead while sleeping with an intoxicated parent on a couch (wedged between the parent and the back of the couch), whose parent admits to the overlay/wedging, and whose autopsy and

laboratory studies do not reveal pathologic alterations, can be classified in a straightforward fashion as an accidental asphyxia (e.g., wedging, overlay, or mechanical asphyxia).

“Gray Zone” Cases of Unexpected Infant Death

Coexistence of a Preexisting Condition With an External Stressor Or Injury

Determination of the cause of death is not always straightforward. In addition to considering the evidence that is collected in any one case, practitioners should also be aware of the impact of their own philosophical doctrine of causation (33), the weight of personal training and experience, and the institutional culture in which they practice. When two forensic pathologists are faced with the same facts in a complicated case, it is not unusual for two disparate opinions to be offered; this fact demonstrates the “art” of practicing medicine.

For example, in the case of an infant found by autopsy to have a previously unrecognized potentially lethal

congenital heart malformation, but who was found dead in an unsafe sleep environment, the possibility of an asphyxial mechanism contributing to or causing death, is significant. In such a case, the combination of a potentially lethal natural disease with an external stressor may logically and rightfully lead to a diagnosis of sudden death due to the heart malformation, precipitated by the physiologic strain of breathing (and possibly rebreathing) within an unsafe sleep environment. In medical examiner parlance, this would be an accidental death. Another forensic pathologist might logically and reasonably argue that the infant died *with* the heart malformation, and not *of* the heart malformation, and that the death was purely asphyxial in nature. Alternatively, a forensic pathologist might argue that the heart malformation was the most important finding, and that the external environment played some role (from none to significant; depending on the details of the case), hence, resulting in the death being considered natural, undetermined, or accidental in manner. Careful consideration of all the case information can result in defensible diagnoses, and yet, controversy may remain. It is impossible to give specific recommendations on an approach to the deter-

Table 5: Recommendations For Classification of “Classical” Unexpected Infant Death Cases

Case	Circumstances	Autopsy	Laboratory	Classification
1	Safe sleep environment; no historical elements of concern	Within normal limits	Within normal limits	Undetermined cause and manner of death
2	Markers of an unsafe sleep environment in the absence of admitted overlay, wedging, or accidental strangulation or suffocation	A natural disease process that negatively impacted cardiac or respiratory function (or both)	Within normal limits	Probable asphyxia (“type”), contributed to by “natural disease” (specify type). Accidental manner of death, OR “Natural disease” (specify type) contributed to by probable mechanical asphyxia. Accidental manner of death.
3	Markers of an unsafe sleep environment in the absence of admitted overlay, wedging, or accidental strangulation or suffocation	Within normal limits	Within normal limits	Undetermined cause and manner of death, OR Probable mechanical asphyxia (“type”). Accidental manner of death
4	Bed sharing with parent/caregiver, denials of overlay/wedging	Within normal limits	Within normal limits	Undetermined cause and manner of death
5	Bed sharing with parent/caregiver, denials of overlay/wedging	Findings suggestive of smothering, suffocation (including abnormal lividity patterns)	Within normal limits	Mechanical asphyxia (or more specific label, if applicable and believed to be more accurate)
6	Admitted overlay, wedging or accidental strangulation or suffocation	Findings suggestive of smothering, suffocation (including abnormal lividity patterns), and/or within normal limits	Within normal limits	Accidental “asphyxia” (specify type including overlay, wedging, strangulation, suffocation)

mination of cause and manner of death in these types of complex cases. In general, in keeping with basic standards of practice, forensic pathologists should carefully consider all of the available investigative and medical evidence, and offer logical opinions that are supported by that evidence.

Documented Risk Factors for Asphyxia Without Circumstantial Or Physical Evidence

It is not uncommon for an infant to be found dead in an unsafe sleep environment such as bed sharing with a parent, but the parent denies overlaying the infant, or otherwise causing or contributing to asphyxial circumstances. Postmortem examination on the infant subsequently does not reveal unusual patterns of lividity, or pathologic findings to explain the death. Whilst it is highly prudent to regard, and communicate the unsafe nature of the sleep environment to the parents and to agency stakeholders, we do not consider it to be best practice to determine that an accidental asphyxial event has necessarily occurred. We recommend labeling such deaths as undetermined in cause and manner, and then offering an opinion about the competing possibilities of 1) asphyxia in an unsafe sleeping environment, 2) undetectable and as-of-yet unknown lethal natural diseases, or 3) some combination of the two.

Anatomic Evidence of Asphyxial Mechanisms in the Face of Caregiver Denials

When an infant is found dead with highly suggestive anatomic evidence of an asphyxial mechanism of death (e.g., anterior lividity pattern with blanching of the nose and mouth), but caregivers deny knowledge of such an event, it may be appropriate to conclude that the infant died as the result of mechanical asphyxia (or any more specific subtype of asphyxia) given the supportive circumstantial evidence and the absence of a definitive anatomic cause of death. Forensic pathologists are reminded that despite the sometimes very vocal complaints and denials of caregivers, the ruling that an infant died an asphyxial death is not predicated upon caregiver approval.

CONCLUSION

Adoption of a thorough, modern, truth-seeking paradigm will enable forensic pathologists to reach reasonable and defensible conclusions when they are challenged by the investigation of an unexpected infant death. Utilization of such methodology should result in a system of death investigation that has a very small number of truly unexplained infant deaths. When, despite thorough and methodical forensic pathology work, an infant's death still remains unexplained, that case likely represents the manifestation of what was originally intended in the true spirit of the SIDS label. Once every line of investigation has been exhausted, it is more likely than not that the infant experienced a functional or physiological death. "True" SIDS-like cases will persist for much of human history, or at least until forensic pathologists develop the knowledge and technology to document and interpret *functional* changes at autopsy, and subsequent treatments are found for those functional derangements.

When faced with communicating death investigation findings to family members, forensic pathologists need to gain comfort in their capacity to admit both when they cannot explain death, and when the death was, in fact, the result of an asphyxial event. Ignoring the asphyxial mechanism(s), or worse, acknowledging those mechanisms as risk factors for SIDS, not only interferes with the grieving process but also increases the likelihood that other infants in that family will die a similar death. After all, SIDS, when used in its commonest form, tells caregivers that they "did nothing wrong." On occasion, it is the caregiver's actions and behaviors (however inadvertently), that caused the infant's death. As advocates for truth through science, the forensic pathologist must be able to convey that truth to caregivers.

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