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NEONATICIDE

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Introduction

Generally, infanticide refers to the killing of a young child under the age of 12 months, with the term neonaticide being reserved for murders where the victims are under 1 month of age. The boundaries are blurred however, with variable cut-off points for neonaticide being reported at 24 h, 28 and 30 days. The majority of neonaticides occur within several hours of birth and are a response to unwanted pregnancies and deliveries. The assessment of such cases is often difficult as the bodies of the victims are usually hidden and injuries may not be found on autopsy examination. Due to the unique situation of a newborn child, simple omission of adequate care may result in rapid death. Even determining whether an infant was alive at the time of delivery may not be possible from the scene and autopsy investigations. Further methods for determining whether live birth had occurred or whether the infant was born dead are also inexact and may not be able to be applied with any precision. For these reasons extreme caution must be taken in the assessment of these cases. Generally, this article will deal with deaths occurring at or soon after birth.

Historical Background

Both neonaticide and infanticide have been practiced in most communities since earliest recorded times. Unwanted infants were sometimes drowned or smothered if they were perceived to be a financial burden for the family or community, and female infants were particularly vulnerable. In groups as diverse as the Spartans, Inuit, and Bedouin, unwanted infants would be left in the open to die from exposure, dehydration, animal attack, or hypo/hyperthermia. The Vikings and Celts sacrificed newborns to various gods as part of complex pagan rituals. In Europe during the reformation, church leaders advocated the drowning of infants with intellectual impairments. Such infants were sometimes allowed to starve to death and a separate category for "overlaid and starved at nurse" can be found in the Bills of Mortality for the City of London in the seventeenth century. Decline in the numbers of cases of neonaticide has been reported in more recent times in communities where there have been alterations in social attitudes to pregnancies outside marriage, improvements in contraception and sex education programs, and better social welfare programs for single mothers.

Case Characteristics

Mothers who kill their newborn infants are typically young and single, with a low level of formal education. They usually do not have a criminal record and have not attempted to seek an abortion. The pregnancy may have been denied by the mother, or she may simply not have been aware of it. When the delivery occurs it is often a solitary and secretive act with subsequent concealment of the infant. Death may have been actively induced by a variety of methods including suffocation by smothering or strangulation, drowning, or head trauma from blunt-object impact. Alternatively death may have occurred from hemorrhage due to failure to tie off the umbilical cord, or from suffocation from being wrapped in a plastic bag for disposal (Figure 1). Failure to provide nutrition may result in fatal dehydration or starvation, and lack of appropriate clothing may lead to death from hypothermia.

The secretive nature of the delivery means that there will have been no provision of medical care. Thus, mothers may present to emergency departments shocked from blood loss with continued hemorrhage, or with retained products of conception. In spite of the presence of a retained cord and placenta, the pregnancy and recent delivery may still be forcefully denied.

The motivations for such an act are ill understood; however despite assertions that the mothers show no

Figure 1 A term infant who was found wrapped in a plastic bag in a garbage bin following a concealed pregnancy and delivery. The end of the cord had been cut but not tied. A Guedel airway and monitoring lead were left with the body following unsuccessful attempts at resuscitation.

evidence of psychiatric illness, cases have occurred where there have been dissociative hallucinations and depersonalization. Mothers have described being removed from the event and of "watching" themselves during the delivery. The pregnancy and delivery may be denied and this may be a manifestation of underlying florid psychosis, possibly triggered by the event. Legislation in the UK acknowledged the possibility of puerperal psychiatric disturbance or depression, stating that a mother may have "the balance of her mind … disturbed by reason of her not having fully recovered from the effect of giving birth to the child or by reasons of the effect of lactation consequent on the birth of the child." There may be long-standing psychiatric disturbance with occasional reports documenting mothers who have committed multiple neonaticides/infanticides over a number of years.

In other cases, however, the motivations may be more obvious, with neonaticide committed to hide the birth from family members because of feelings of shame and concern that there may be rejection or punishment. Contraception may have failed or a mother may have delayed too long to enable an abortion, or may have been prevented from obtaining one by societal, family, or religious restrictions. Delivery may be hidden from a spouse if the pregnancy was the result of an extramarital affair. Other motives include financial anxieties about raising a child, not wanting the responsibility of parenthood, or concerns that parenthood may interfere with employment. In these cases there may have been quite elaborate lengths taken to ensure a private delivery and successful disposal of the body. These features mitigate against underlying mental impairment or incapacitating mental illness.

Scene Examination

Infant bodies may be disposed of in a variety of ways. In cases where mothers are suffering from psychosis, there may be minimal attempts to disguise the birth. In these situations the infant may be found at the site of delivery. Alternatively, young mothers may attempt to hide bodies around the house in a box in the attic, in the back of a cupboard, or they may bury the body in the garden or in an under-floor space (Figure 2). In other instances the body may be taken away from the place of birth and hidden in isolated woodland, a rubbish dumpster, or a public washroom. The method of disposal reflects access to locations and varies among countries. For example, a favored method of disposing of infants and/or their bodies in Japan has been to leave them in coin-operated lockers in railway stations. This method has declined in recent years with increased surveillance of stations.

In cases where the body of a recently delivered infant has been found in a house with limited access there is often minimal difficulty in determining who the likely mother was. When a body has been found in a public area with unrestricted access, for example a rubbish bin at a university campus, the list of possible mothers may be extensive.

Materials that are found with the body, such as blankets, sheets, or household rubbish, should be retained for formal examination as these may provide significant clues to the origin of the infant and possible places of delivery.

Pathological Findings

Examination of the infant should be undertaken in a standard fashion with careful external examination of the body for evidence of inflicted injury. Cases of asphyxia or drowning will not usually have any unusual findings. Blood-staining and vernix caseosa (white material that is normally adherent to the skin of a fetus) may be present, indicating recent delivery. Conversely, their absence may merely mean that the body was washed before disposal. The finding of injuries such as stab wounds or skull fractures and cerebral lacerations from blunt trauma suggest that the infant was live-born.

Evidence of dysmorphism should be documented and photographed as this may indicate significant underlying associated diseases or conditions that may have been responsible for death. Growth parameters such as crown–heel and crown–rump lengths, head and chest circumference should be measured, as well as weight and foot length.

Internal examination may reveal conditions that are incompatible with survival, such as severe

Figure 2 (A) The skeletonized remains of three near-term infants were found beneath the floor of a 70-year-old house. No bony injuries were found and the causes of death remained undetermined. Given the likely age and nature of the remains it was not surprising that police investigators were unable to shed any light on the discovery. (B) A trapdoor in a floor that had been concealed by a carpet. (C) A close-up of debris beneath the trapdoor, including infant long bones (arrowheads) and skull fragments (asterisk).

pulmonary hypoplasia from congenital diaphragmatic hernia (Figure 3). Microbiological samples, including blood cultures and swabs in nonputrefactive cases, are important in identifying or excluding significant infectious conditions.

Major difficulties often arise in the pathological assessment of these cases as injuries may be very subtle, and proving live birth may not be possible. The legal definition of live birth may also not be particularly clear and may differ from jurisdiction to jurisdiction. Requirements for "independent existence" also vary and may include complete expulsion from the birth canal, a detectable heartbeat, and/or respiratory efforts.

Cases of intrapartum death of normally formed term infants may occur during deliveries in hospital. Autopsies in such cases may be noncontributory, revealing no abnormalities, demonstrating clearly that mechanisms of death may be far from clear even under highly controlled conditions.

The goals for the pathologist faced with a case of possible neonaticide are to estimate the gestational age of the infant, to check for underlying diseases or conditions that may have caused death, to document injuries, to make an assessment of whether live birth occurred, to help establish the identity of the mother, and to determine the cause, mechanism, and manner of death. None of these goals may be achievable in certain cases, for example when all that is left are skeletal remains.

The gestational age can be determined from an examination of both the placenta and the infant. Maturation of chorionic villi may provide an approximate guide to gestational age while growth parameters such as foot length can be plotted against standard charts found in texts and on internet sites. Radiological examination is mandatory, as ossification centers will provide a more accurate determination of infant age than pathological assessment. Standard charts listing the time of appearance of ossification centers are widely available. In addition, radiographs may pick up significant underlying conditions such as skeletal dysplasias that will not be found by routine autopsy examination.
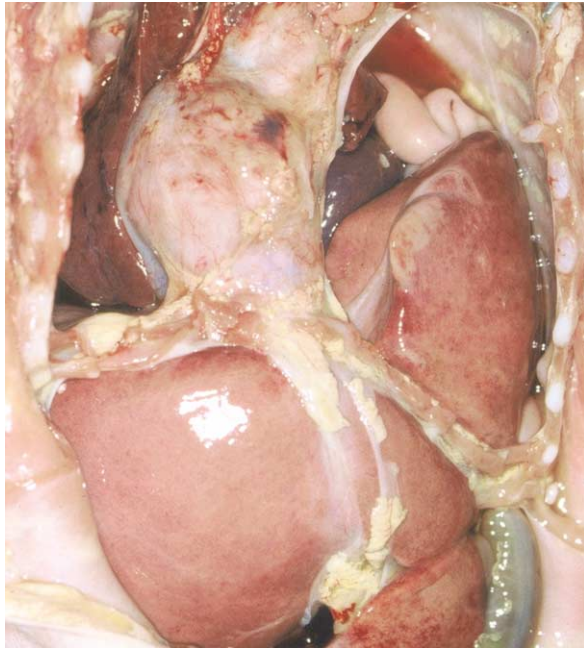
Figure 3 A diaphragmatic hernia responsible for death in a term infant showing herniation of the stomach, small intestine, and part of the liver through a defect in the left dome of the diaphragm, with pulmonary hypoplasia and displacement of the heart and mediastinum to the right.

Figure 4 Marked maceration indicating *in utero* death in an infant with dysmorphic facial features, suggesting the possibility of an underlying chromosomal abnormality.

The chance of fetal survival increases with gestational age, with otherwise well infants born at 28 weeks now expected to live. Even less mature infants may survive, although often requiring medical support. In different jurisdictions an infant of 24 or 28 weeks' gestation or more is considered viable and capable of independent existence.

Determination of live birth is often difficult as there may be no way to prove that an infant had independent existence, with a heartbeat and complete expulsion from the birth canal. It is far easier to suggest that an infant was not born alive if there are signs of intrauterine death. A maternal history of cessation of fetal movements may be obtained. In addition, when a dead infant has remained *in utero* for some time sterile tissue breakdown occurs, producing characteristic changes of maceration (Figure 4). It can be confidently stated that a macerated infant has not been alive outside the uterus. Typical changes include reddening of the skin with peeling and slippage occurring approximately 12 h after death, with purple mottling and blister formation after 24 h, and the accumulation of reddish autolytic effusion fluid in the peritoneal, pleural, and pericardial spaces after 48 h. The body loses tone and joints become hyperextensible. After several days the brain softens and the skull begins to
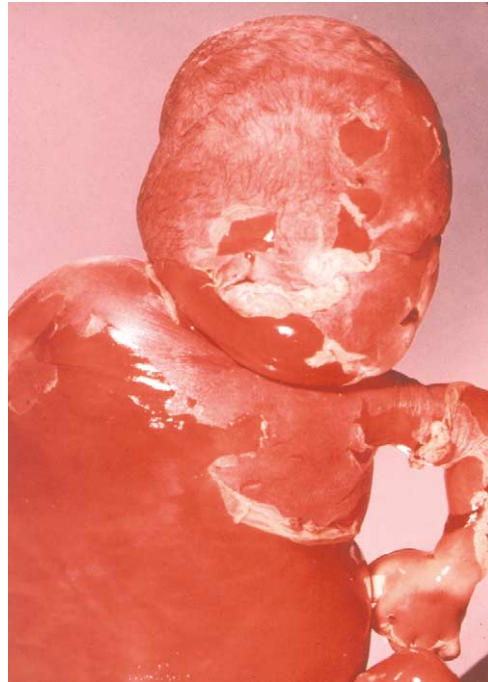
collapse with overriding of cranial bones. This may be picked up on radiographs and is known as Spalding's sign.

Although it has been proposed that shed fetal skin (squames), and/or meconium within the alveoli indicates stillbirth, this is incorrect. Meconium staining of the body (Figure 5) or under the nails merely indicates that fetal distress has occurred before or during delivery and suggests that the infant may have been compromised before labor was initiated. While there are certainly increased amounts of intraalveolar squames when there has been fetal stress, they are not an uncommon finding in the lungs and may be detected for some time after an apparently normal delivery. Frothy pulmonary edema fluid within the airways may be an indication of survival. While pulmonary interstitial emphysema has been proposed as a marker for live birth, its reliability is yet to be determined.

The usefulness of the so-called "birth line" in teeth is arguable. This finding results from disturbance of ameloblast activity at birth and may be detected at about 3 weeks of age. Although scanning electron microscopy may detect changes as early as the first 1–2 days of life, this is of limited use as the majority of neonaticides occur immediately after delivery.

Figure 5 Meconium staining of a term infant indicating intra-partum stress. Delivery had occurred into a toilet bowl following a concealed pregnancy.

Figure 6 Well-aerated lungs floating in water in a case of alleged stillbirth without attempted resuscitation. The infant was not putrefactive.

Figure 7 Dark-red underinflated lungs from a genuine still-birth contrast with the salmon-pink lungs from the previous case (**Figure 6**) that showed obvious inflation. They failed to float in water.

Flotation Test

This test, known initially as "docimasy" or "hydrostasy," was first proposed by Swammerdam in 1667 to differentiate stillborn lungs from those of infants who had breathed. It involves placing the lungs in water to see if they float. Although variations have been proposed in which the heart and lungs are placed in water *en bloc*, in an attempt to increase the sensitivity and specificity of the test, it remains controversial.

The basis of the test is an assumption that the lungs from an infant who has breathed will be inflated, with expansion of the distal airways, and will therefore float in water (**Figure 6**). Their spongy texture and salmon-pink color contrast with the dense texture and dark-red appearance of lungs (**Figure 7**) from a stillborn infant that will sink when "hydrostasy" is attempted.

Significant problems exist, however, as lungs from stillborn infants may float if there is putrefaction with gas generation by bacteria, or if there has been attempted resuscitation with inflation of the airways by positive pressure. Infants who are born alive may breathe only very weakly, or may exhibit agonal gasping that may not be of sufficient force to open alveoli. There may be only patchy and partial inflation with an admixture of collapsed and inflated alveo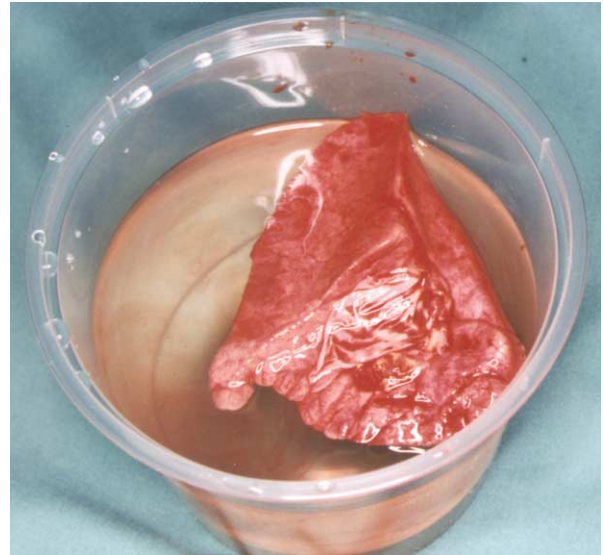li producing a mottled appearance. These lungs may not float. Liver has been used as a control tissue on the basis that normal liver will sink, whereas putrefied liver with gas cysts will float.

Alternatives to the flotation test such as the test of Ploucquet have also been discredited. This relied upon comparisons of the absolute weight of the lungs to the body weight to determine whether respiration had taken place, i.e., inflated lungs that are perfused with blood will be heavier than lungs where respiration has not occurred. This has also been shown to be highly inaccurate.

Radiographs may be used to assess whether air is present uniformly throughout the lung fields and/or

Figure 8 An air-filled stomach from an alleged stillbirth floating in water. There had been no attempts at resuscitation.

in the stomach. Again, the presence of air in the stomach (Figure 8) and small intestine may indicate that the infant has survived long enough to swallow air. However, the possibility of air being forced into the stomach during attempted resuscitation or being generated by bacteria during postmortem putrefaction must be considered. Putrefactive gas formation may be confirmed if abdominal radiographs show gas within the vessels of the liver. Air within the middle ears has been used as an indicator of live birth but is subject to the above caveats.

Another feature of live birth that may be present is milk within the stomach indicating that an infant had been fed prior to death. Histological examination of the umbilical cord may also reveal a vital reaction. Reports from the mother or independent observers of an infant crying or moving may confirm live birth.

Cause of Death

Failure to provide adequate care to a newborn infant may result in death from exsanguination if the cord is not clamped, from upper-airway obstruction if the airways are not cleared, or from hypothermia if an infant is not kept warm or is left exposed to a cold environment. Other common methods of neonaticide are asphyxia due to smothering or strangulation, or blunt-head trauma. Drowning may occur if an infant is delivered into a toilet bowl or is held underwater in a bath. Stabbing is less common and poisoning is rare. In the past it was alleged that midwives caused deaths of unwanted infants by pushing needles through fontanels or under eyelids. Deaths in these cases would result from intracranial hemorrhage if venous sinuses were torn, or from sepsis.

As previously noted, the autopsy findings in cases of smothering or drowning are usually nonspecific, and unless the event has been witnessed or the perpetrator confesses, the cause of death may not be established. Delay in finding the body may also result in putrefactive changes with insect infestation that may alter, disguise, or simulate injuries. Smothering may result from a hand being placed over the mouth and choking may occur if cloth is forced into the mouth. Circumferential marks around the neck may be left from ligature strangulation, although it is important not to confuse these with normal skin creases or impressions from the umbilical cord if it has been wrapped around the neck during delivery or postmortem. Facial petechiae are usually not present in cases of infant smothering or strangulation. Although a cloth ligature around the neck suggests ligature strangulation, even this must be viewed circumspectly, as it has been reported that cloth may be tied around the neck by a mother to assist with traction in cases of obstructed self-delivery. Fingertip bruising or fingernail scratches may be found on the neck in cases of manual strangulation. Again, it is important not to mistake these for marks caused by the mother attempting to deliver the infant by herself.

If injuries are detected they must be differentiated from birth trauma that is most likely to occur with malpresentation of the infant and/or from prolonged labor. Comparing the pattern of injury to that of inflicted injury reveals differences which are explainable when the history of the labor and presentation of the infant are ascertained. For example, difficult breech deliveries may be associated with fractures or separation of parts of the occipital bone, so-called occipital osteodiastasis. When this occurs there may be tearing of venous sinuses in the posterior part of the cranial cavity with extensive subdural hemorrhage and cerebellar lacerations. Unfortunately, due to the nature of many of these cases, specific information about the labor and delivery will not be available.

Common birth-related injuries include caput succedaneum (bleeding and edema within the soft tissues of the scalp) and cephalhematoma (bleeding under the periosteum). The amount of hemorrhage associated with these injuries is not life-hreatening. Skull fractures are not common and are usually linear fractures of the parietal bones occurring during difficult forceps deliveries. There may be associated extra- and subdural hemorrhages.

Other birth-related injuries include spinal injuries, fractures of the clavicles and long bones, and trauma to internal organs such as the spleen and liver.

Obstructed labor from cephalopelvic disproportion or shoulder dystocia may result in infant death from asphyxia. This may also occur in smaller infants if there has been rapid delivery. If a mother was standing or crouching during a precipitate delivery head injuries may result from the infant striking the floor. Obviously the cord has to be of sufficient length for this to happen. Measurements of the cord length should, therefore, be compared to measurements of the height of the mother's perineum from the ground.

Evidence of lethal natural diseases should also be carefully sought. These may be reasonably obvious, with conditions such as congenital diaphragmatic hernias with pulmonary hypoplasia, anencephaly, or chromosomal disorders providing acceptable causes of death. Subtle but serious cardiovascular anomalies, metabolic conditions, or sepsis may, however, be harder to identify. If death has occurred during delivery there may be evidence of previous intrauterine stress with reduced subcutaneous fat, poor growth, and meconium staining of the skin and under the fingernails. Findings at autopsy to support death due to an acute asphyxial event during delivery may include epicardial, pleural, and thymic petechiae with histologic findings in the lungs of intraalveolar hemorrhage, aggregates of meconium, and squames.

If a mother is located there are certain maternal conditions that can be checked for that are associated with poor fetal growth and the possibility of intrapartum asphyxia. These include diabetes mellitus, preeclampsia, hypertension, anemia, and heart or kidney diseases. Prolonged gestation (>42 weeks) and a high number of previous pregnancies may also be associated with poor infant outcome.

Maternal Identification

DNA comparisons between an alleged mother and an infant can be undertaken to assist in maternal identification. For this reason tissue and blood sampling at autopsy should be performed.

Placental Examination

As placental abnormalities may be responsible for the demise of an infant it is important to conduct a careful examination of the placenta if possible. Unfortunately the body of an infant may have been disposed of separately from the placenta and so the placenta may not be available for examination.

Conditions that may be responsible for infant death include premature separation of the placenta, abruptio placentae with extensive retroplacental hemorrhage (Figure 9) and compromise of cord blood supply. A large blood clot may still be present adherent to the maternal surface of the placenta, or if it has been dislodged there may be an indentation indicating its position. Marked hemorrhage may also occur with placenta or vasa previa when the placenta or cord is overlying the entrance to the birth canal. Vessels and tissues become traumatized at the initiation of labor. Similarly, vessels may be damaged when there is velamentous insertion of the cord into the membranes rather than the body of the placenta, again with substantial and potentially life-threatening hemorrhage. Although infant mortality with such an occurrence is 60–70%, autopsy examination of an affected infant in isolation may not reveal any abnormalities.

Other problems leading to intrauterine or peripartum death include marked placental infarction (Figure 10) or sepsis. Cultures of the placenta may reveal the causative organism and histological examination of the cord and the placenta may show funisitis, villitis, or chorioamnionitis. Immunohistochemical staining has been used to delineate pathogenic infectious agents within placental tissue.

Figure 9 Significant amounts of retroplacental clot (arrow) in a case of abruptio placentae causing infant demise in an out-of-hospital delivery.

Figure 10 Multifocal areas of placental infarction.

Figure 11 Three irregular incisions at the end of an umbilical cord (arrows) in a case of home delivery of an alleged stillborn term infant. No vital reaction was seen on microscopy.

The length of the umbilical cord should be measured as it may have a direct bearing on the reasons for infant demise. Asphyxia has been reported during labor from traction on excessively short cords (<30 cm), whereas long cords (>100 cm) have been associated with torsion, prolapse, knotting, and wrapping around the neck. The average cord length is 54–61 cm. The cord should also be examined for the presence of knots that may have interfered with the infant's blood supply. Loose knotting is not uncommon and is not significant; however, a tightly knotted cord will have narrowed vessels with congestions and edema on one side and pallor on the other. Histologically, there may be thrombi within cord vessels. The significance of twisting of the cord may be even more difficult to ascertain. Cords that have wrapped around the neck may also be important if there has been compromise of the infant's cerebral blood supply or airway. The severed ends of the cord should be examined and photographed to document whether the cord was cut (Figure 11) or torn, possibly during a precipitate delivery.

Dessication and separation of the umbilical stump begin after 24–48 h. An earlier change seen microscopically may be the presence of a vital reaction at the severed ends, indicating that there had been survival for some time after delivery. There may also be thrombosis of umbilical cord vessels with early organization. If death occurred immediately after delivery none of these changes will be present.

Conclusion

The investigation of possible neonaticide and concealment of birth is difficult as pathological findings may be subtle or nondiagnostic. For these reasons it is important to realize that in certain cases it may simply not be possible to determine whether live birth occurred, or to arrive at the cause of death with any certainty. In these cases it is appropriate to assume that an infant was stillborn until evidence to the contrary can be produced, with death being classified as "unascertained" or "undetermined."

See Also

Children: Sudden Natural Infant and Childhood Death; Non-inflicted Causes of Death; **Sudden Infant Death Syndrome, Etiology and Epidemiology**

Further Reading

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Nuclear Terrorism   *See* **Terrorism:** Nuclear and Biological