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Forensic Research Progress on Neonatal Deaths and Related Medical Disputes: A Comprehensive Review

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Abstract

Medical disputes arise when patients or their families disagree with healthcare providers regarding adverse outcomes or their causation during medical care, subsequently demanding compensation, accountability, and initiating administrative or legal proceedings. Heightened public awareness of rights, coupled with insufficient understanding of medical complexities among families, frequently impedes consensus between healthcare providers and patients. This dynamic contributes to a rising annual incidence of medical disputes stemming from neonatal deaths, transforming it into a significant societal concern. The neonatal period represents a critical phase of adaptation to extrauterine life, characterized by incomplete organ development, poor environmental adaptability, and weak resistance. Any factor – medical error, birth trauma, or inappropriate nursing/feeding – can readily precipitate disease or death. The acute onset, rapid progression, and unpredictable outcomes of neonatal diseases further establish Neonatology and Obstetrics as high-risk specialties for disputes. In forensic practice, neonatal asphyxia remains a predominant cause of death. However, limitations in clinical asphyxia diagnosis render related fatalities particularly challenging in forensic examination and determination. The unique anatomy and physiology of neonates (e.g., organ immaturity, low immunity) increase vulnerability to threats like infection and asphyxia, resulting in high mortality rates. This vulnerability not only fuels the increase in disputes but also presents substantial challenges for forensic identification. Global data underscores the severity of neonatal mortality: WHO reports approximately 4 million neonatal deaths annually, accounting for 43% of under-five child mortality; 75% occur within the first week of life, and 50% within the first 24 hours. Blencowe H (2010) identified the primary

global causes as prematurity and complications (35%), infection (27%), and intrapartum complications (23%). China exhibits regional disparities: economically developed areas mirror developed nations (birth defects and prematurity as leading causes), while less developed regions are dominated by asphyxia and infectious diseases. Current research predominantly focuses on clinical aspects of neonatal death; systematic studies from the perspective of medical disputes remain insufficient. Investigating the changing patterns of causes of death, mortality proportions at different time points, and triggers for disputes across time is crucial for clarifying contemporary dispute characteristics and providing insights for healthcare institutions to mitigate risks.

Keywords

Newborn, Death, Medical Dispute, Forensic Medicine, Asphyxia, Autopsy, Risk Factors, Prevention

1. Introduction

Medical disputes arise when patients or their families disagree with healthcare providers regarding adverse outcomes or their causation during medical care, subsequently demanding compensation, accountability, and initiating administrative or legal proceedings (Adamson, Campbell, et al., 2009). Neonatal mortality rate (NMR) serves as a critical indicator of a nation's healthcare quality and socioeconomic development (Gudayu, 2023; Gasper, Stuchlik, Stukel, & Goodman, 2025; Deviany et al., 2022; Haileamlak, 2022; Paul, Kumar, & Zodpey, 2016; Parmigiani & Bevilacqua, 2022; Akinyemi, Bamgboye, & Ayeni, 2015; Sousa et al., 2024; Sun et al., 2013; Kawakami et al., 2021; Soni et al., 2025). Globally, approximately 4 million infants die during the neonatal period annually, constituting over 60% of under-five child mortality, with half occurring within the first 24 hours of life (Lozano et al., 2012; Oza, Lawn, Hogan, Mathers, & Cousens, 2015; Wang, Ren, & Liu, 2023). Consequently, Neonatal Intensive Care Units (NICUs) operate under immense pressure and represent a high-risk environment for medical disputes. The past decade has witnessed a significant surge in related cases. Early neonatal deaths (within 7 days of life) account for 69.7% of mortality cases. Etiological analysis reveals a shift: the initial six-year period was dominated by aspiration pneumonia, asphyxia, hyaline membrane disease, sepsis, and sclerema neonatorum (primarily respiratory diseases); the subsequent six years saw respiratory diseases, congenital malformations, and craniocerebral disorders as leading causes. Asphyxia consistently ranked as the primary cause of death. Disputes occur most frequently in county-level hospitals, with higher rates of misdiagnosis observed in private hospitals and individual clinics. Key forensic pathological findings supporting asphyxia include multi-organ dysfunction secondary to umbilical cord abnormalities, foreign body aspiration, or intrauterine asphyxia. Obstetric clinical factors (e.g., amniotic fluid, placental, umbilical cord, membrane abnormalities; malpresentation; abnormal labor; prematurity; pregnancy complications) provide corroborative evidence for forensic asphyxia diagnosis. The inherent vulnerability of neonates constitutes a fundamental objective factor underpinning disputes: incomplete organ development and compromised immunity (especially in preterm/low birth weight infants) predispose them to severe illness; subtle

clinical signs, rapid deterioration, and high case fatality rates create immense diagnostic and therapeutic challenges (Paratz et al., 2023). Communication breakdowns and eroded trust significantly contribute to disputes. Closed NICU management limiting family presence can foster distrust; inadequate physician-family communication and perceived poor service attitude exacerbate the situation. Negative media portrayals further amplify family skepticism regarding the care process (Paratz et al., 2023; Kopelman, 2006). Profound sociocultural and psychological factors play a crucial role. Historical policies like the one-child policy have intensified familial expectations placed upon newborns, rendering acceptance of adverse outcomes, particularly death, exceedingly difficult (Paratz et al., 2023; Kopelman, 2006). Technical deficiencies in diagnosis, treatment, and nursing are critical precipitating factors. Obstetric limitations include constraints in prenatal prediction and diagnosis; the inherently complex and dynamic nature of labor, prone to sudden pathological events; and inadequate experience among some staff, leading to incomplete assessment of risk factors or improper maneuvers (e.g., forceps/vacuum application causing intracranial hemorrhage or fetal distress), resulting in delayed or inappropriate intervention (GBD 2021 Causes of Death Collaborators, 2024). Pharmacological errors represent a significant avoidable cause of mortality. Neonatal pharmacotherapy demands strict adherence to indications, contraindications, and precise dosing ranges. Overdosing or inappropriate fluid administration (e.g., excessive sodium-containing fluids precipitating heart failure/pulmonary edema) are critical errors frequently implicated in fatal outcomes and subsequent disputes (Paratz et al., 2023; Kopelman, 2006). Economic and systemic pressures compound the problem. The advanced technology and associated high costs of NICU care often impose catastrophic financial burdens on families. Treatment failure or death following substantial expenditure can rapidly escalate dissatisfaction, leading to unpaid bills and impacting hospital operations. Deficiencies in medico-legal awareness and documentation are pervasive risks. Insufficient understanding of legal obligations among some healthcare workers results in neglect of the timeliness, objectivity, and legal validity of medical records. Inadequate fulfillment of informed consent obligations, particularly the lack of thorough documentation and formal signatures, creates fertile ground for disputes. Poor communication skills, especially among junior physicians lacking clinical and interpersonal experience, can lead to inadequate or insensitive delivery of critical information regarding the infant's condition and prognosis. The broader media environment often exacerbates tensions; sensationalized or irresponsible negative reporting can place healthcare institutions in a defensive position before any formal investigation concludes (Hodkinson et al., 2022).

2. High-Risk Factors for Neonatal Mortality

Neonatal death is defined as the death of a live-born infant (exhibiting breathing, heartbeat, or only heartbeat at birth) occurring within the first 28 days of life (Lozano et al., 2012). Global statistics reveal the stark reality: WHO estimates approximately 4 million neonatal deaths annually, constituting 43% of under-five mortality; 75% of these deaths transpire within the first week (Lozano et al., 2012; Oza,

Lawn, Hogan, Mathers, & Cousens, 2015; Wang, Ren, & Liu, 2023; Paratz et al., 2023; Kopelman, 2006). Alarmingly, 98% occur in low- and middle-income countries (Gudayu, 2023; Gasper, Stuchlik, Stukel, & Goodman, 2025; Deviany et al., 2022; Haileamlak, 2022; Paul, Kumar, & Zodpey, 2016; Parmigiani & Bevilacqua, 2022; Akinyemi, Bamgboye, & Ayeni, 2015; Sousa et al., 2024; Sun et al., 2013; Kawakami et al., 2021; Soni et al., 2025; Lozano et al., 2012; Oza, Lawn, Hogan, Mathers, & Cousens, 2015; Wang, Ren, & Liu, 2023; Paratz et al., 2023; Kopelman, 2006). China, despite progress driven by economic growth and healthcare advancements (particularly in preterm care, obstetric techniques, and NICU development), still exhibits a higher NMR compared to developed nations, with significant regional disparities in leading causes (Fang et al., 2024; Xu et al., 2022). Economically developed regions report birth defects and prematurity as primary causes, whereas less developed areas contend predominantly with asphyxia and infectious diseases (Lozano et al., 2012; Kopelman, 2006; He, Zhang, Liu, Li, Wang, Zhang, & Chen, 2023; Deng, Wang, Zhou, Ren, & Liu, 2019). Understanding the major causes and their pathophysiological mechanisms is paramount: Perinatal Asphyxia: Perinatal asphyxia is one of the three most important causes of neonatal mortality and morbidity (Improda et al., 2023; Hill, Reed, & Brown, 2021). It is a critical factor underlying cerebral palsy, intellectual disability, and death in newborns (Herrera et al., 2017; Ma et al., 2019), and is closely linked to prematurity, low birth weight, congenital anomalies, and adverse perinatal events. WHO (2005) data indicates asphyxia contributes to approximately 23% of neonatal deaths (Liu, Johnson, Cousens, et al., 2012), often representing a continuation of intrauterine distress. Severe asphyxia can trigger devastating complications including massive pulmonary hemorrhage, meconium aspiration syndrome (MAS), hypoxic-ischemic encephalopathy (HIE), intracranial hemorrhage (ICH), and hypoxic-ischemic myocardial injury, culminating in multi-organ failure and death (Liu, Johnson, Cousens, et al., 2012; Iribarren, Hilario, Álvarez, & Alonso-Alconada, 2022). Aspiration Pneumonia: Caused by intrauterine aspiration of amniotic fluid/meconium or postnatal inhalation of breast milk (Shaikh, Irfan Waheed, Javaid, Gul, Hashmi, & Fatima, 2016; Cotoi et al., 2019; Hersh, Sorbo, Moreno, Hartnick, Fracchia, & Hartnick, 2022; Stanley et al., 2019), it carries a domestic mortality rate of 11%-13% (Bryce, Boschi Pinto, Shibuya, et al., 2005). Its pathogenesis is strongly associated with perinatal hypoxia/asphyxia (e.g., prolonged labor, placental abruption, cord complications) (Zhang et al., 2020). Hypoxia stimulates fetal respiratory centers, leading to gasping and aspiration of contaminated fluid, while simultaneously relaxing the anal sphincter and releasing meconium. Aspirated material causes bronchiolar spasm and ball-valve obstruction, resulting in obstructive atelectasis or emphysema (Wardlaw, Johansson, & Hodge, 2006; Wunsch, Wunsch, & Darge, 1999). Infectious Diseases: One of the major cause of neonatal death in China, infections claim nearly 1.6 million neonates globally each year (Yang Chinese, Chen Qingqin, Mao Huijuan, et al., 2013; Hon, Leung, Leung, Man, & Ip, 2020). Neonatal susceptibility arises from immune incompetence and underdeveloped respiratory barriers (Kollmann, Kampmann, Mazmanian, Marchant, & Levy, 2017; John, 2013). Infection routes and pathogens vary: Intrauterine/Intrapartum infections often involve Gram-negative bacilli (transmitted

via contaminated amniotic fluid/blood), causing multi-organ damage (Tsai et al., 2016; Wu et al., 2017). Birth canal infections frequently involve Gram-negative bacteria like E. coli. Postnatal infections feature diverse pathogens (commonly Gram-positive cocci), with viruses (adenovirus, RSV) more prevalent in late neonates. Infectious pneumonia poses a particularly high mortality risk. Neonatal Hyaline Membrane Disease (NHMD)/Respiratory Distress Syndrome (RDS): Primarily affecting preterm/low birth weight infants, it manifests as progressive respiratory failure (cyanosis, grunting, retractions) and high mortality (Li, Zhang, Sun, Chen, & Zhou, 2019; Menahem, Sehgal, & Wurzel, 2023). The core pathology is surfactant deficiency leading to diffuse atelectasis (Hallman & Herting, 2023). Risk escalates dramatically with decreasing gestational age: <28 weeks (60-80%), 32-36 weeks (15-30%), ≥37 weeks (5%) (Sedigheh, Maryam, & Roya, 2009; Madan, Jackson, Figueroa, & Bahado-Singh, 2023). Lower birth weight further increases risk. Additional risk factors include maternal diabetes (6-fold increased risk), multiple gestation, premature rupture of membranes, intrauterine hypoxia, pregnancy-induced hypertension, cesarean delivery (lack of labor stress reduces endogenous steroid surge), and male sex (testosterone may delay lung maturation) (Farrell & Avery, 1975). Pathological hallmark is eosinophilic hyaline membranes lining terminal bronchioles and alveolar ducts. Congenital Malformations (Birth Defects): Defined as structural or functional anomalies present at birth (e.g., neural tube defects, congenital heart disease, gastrointestinal/urinary/limb malformations, chromosomal disorders). Their prevalence in China shows an upward trend: 1.10% (2000) to 1.45% (2013) (Ministry of Health, PRC. 2014). Autopsy studies indicate malformations causing perinatal death most commonly involve the circulatory (39.6%), digestive (24.3%), and nervous (18.1%) systems (Blencowe & Cousens, 2013). Neonatal Intracranial Hemorrhage (ICH): Associated with high mortality and long-term disability. Major types include Periventricular-Intraventricular Hemorrhage (PVH-IVH, most common in preterm infants, 50-60%), subarachnoid hemorrhage, intraparenchymal hemorrhage, cerebellar hemorrhage, and subdural hemorrhage (Blencowe & Cousens, 2013; Delaney, Rooks, Wolfe, et al., 2012). Risk factors encompass prematurity, low birth weight, maternal diabetes, multiple gestation, obstetric cholestasis, nuchal cord, and placenta previa. PVH-IVH is a leading cause of death, cerebral palsy, and cognitive impairment in preterm survivors. Neonatal Hypoxic-Ischemic Encephalopathy (HIE): Brain injury resulting from perinatal hypoxia/ischemia (Ilves, Lintrop, Talvik, et al., 2009; García, Miranda-Novales, Lorenzo-Hernández, & Luna, 2023; Miholjcic, Baud, Iranmanesh, & Wildhaber, 2024). Incidence is approximately 3 per 1000 live births, with neonatal mortality rates of 15-20%; 25-30% of survivors suffer permanent neurological sequelae (language/intellectual deficits, cerebral palsy). Pathophysiology involves disruption of cerebrovascular function and autoregulation. Cerebral blood flow (CBF) decreases within 12 hours post-asphyxia, followed by hyperperfusion between 24-120 hours. Severe HIE is characterized by significantly elevated mean cerebral blood flow velocity (CBFV) peaking at 36-72 hours, accompanied by loss of brain tissue, enlargement of ventricles/subarachnoid spaces/interhemispheric fissure, and reduced head circumference (Ilves, Lintrop, Talvik, et al., 2009;

García, Miranda-Novales, Lorenzo-Hernández, & Luna, 2023; Miholjcic, Baud, Iranmanesh, & Wildhaber, 2024). Pathological changes include status marmoratus of basal ganglia, selective neuronal necrosis/infarction, periventricular leukomalacia, focal/multifocal infarction, parasagittal injury, and enlarged posterior horns of lateral ventricles (Soares, 2018). Sclerema Neonatorum (Cold Injury Syndrome): Characterized by hypothermia and hardening of subcutaneous fat. Predisposing factors include the high melting point of neonatal saturated fatty acids, immature thermoregulatory center, and relatively large surface area, thin skin, and rich vascularization facilitating rapid heat loss (Hwang, Liu, Yu, Cui, & Diop, 2021). Prevalent in cold seasons, severe cases can progress to shock, pulmonary hemorrhage, multi-organ failure, and death. Abusive Head Trauma (AHT): Intentional cranial trauma inflicted by violent shaking and/or impact, with peak incidence between 6 weeks and 4 months of age (Choudhary et al., 2018). Consequences are devastating: high lethality and disability rates (leading cause of child abuse fatalities), mortality ranging from 10-25%; 70.6% of survivors suffer severe disabilities (blindness, paralysis, cognitive impairment). Diagnosis is challenging; approximately 30% are misdiagnosed initially due to non-specific symptoms (vomiting, lethargy) and frequent absence of a disclosed trauma history. Terminology has evolved; "Shaken Baby Syndrome (SBS)" has been largely superseded by "AHT" to reflect the likely contribution of multiple mechanisms (shaking, impact, hypoxia) (Choudhary et al., 2018).

3. Forensic Autopsy in Neonatal Death Investigation

Postmortem examination remains the gold standard for determining the cause of neonatal death, providing objective evidence crucial for resolving medical disputes, improving healthcare quality, and advancing medical knowledge. Forensic pathological assessment of neonates presents unique challenges distinct from pediatric or adult practice, necessitating specific focus on: establishing the precise cause of death, evaluating the role of obstetric maneuvers, identifying any related trauma, determining live birth versus stillbirth status, and assessing viability/maturity. Neonatal anatomical peculiarities demand specialized autopsy techniques: Brain Examination: Due to extreme softness and fragility, standard methods risk creating artifactual damage. The "basket technique" for craniotomy is recommended to minimize iatrogenic injury. Thoracoabdominal Incision: An inverted-Y incision is preferred, facilitating optimal examination of the umbilical vessels. Placenta and Umbilical Cord: The placenta is an indispensable specimen and must always be submitted for examination alongside the infant. Organ Evacuation: In-situ inspection of the great vessels, ductus arteriosus, and heart is essential. En bloc removal of the heart and lungs is advisable to preserve anatomical relationships critical for evaluating congenital malformations. Critical investigative procedures include: Live Birth Determination: The core question is whether spontaneous respiratory activity occurred after complete separation from the mother. The hydrostatic test (lung and stomach floatation test) is a primary method, but its validity is contingent upon the absence of putrefaction. In decomposed cases, microscopic examination of compressed lung tissue fragments may offer clues. Histopathological examination of

lung tissue is paramount, assessing alveolar expansion, presence of foreign material (amniotic fluid, meconium, drowning fluid), and other pathological changes, providing vital evidence for both live birth determination and cause of death analysis (Ding, Lu, Wang, & Hu, 2018; Sawaguchi, Sawaguchi, Matoba, Togari, Nakagawa, Miyauchi, & Nishida, 2002). The tympanic test offers supplementary information. Umbilical Cord and Placental Examination: As the vital interface for fetal-maternal exchange, the placenta holds critical evidence. Umbilical cord abnormalities (e.g., entanglement, hypercoiling, true knots, edema) are common high-risk factors for stillbirth (especially nuchal cord) and intrauterine distress (Sawaguchi, Sawaguchi, Matoba, Togari, Nakagawa, Miyauchi, & Nishida, 2002). Histological evidence of an inflammatory reaction within the umbilical cord can support live birth determination (Sawaguchi, Sawaguchi, Matoba, Togari, Nakagawa, Miyauchi, & Nishida, 2002). Cranial Examination: The presence of space-occupying clots (distinct from the petechial hemorrhages associated with asphyxia) strongly suggests traumatic vascular rupture due to injudicious instrumental delivery (Sawaguchi, Sawaguchi, Matoba, Togari, Nakagawa, Miyauchi, & Nishida, 2002). Cephalohematoma can serve as corroborative evidence of live birth (Sawaguchi, Sawaguchi, Matoba, Togari, Nakagawa, Miyauchi, & Nishida, 2002). Viability (Maturity) Assessment: A comprehensive judgment based on quantitative parameters (e.g., crown-heel length ~50cm, placental weight ~500g, body weight ≥2500g) and morphological features (proportionate body habitus, abundant subcutaneous fat, pink and elastic skin, generally well-nourished appearance) (Pryce, Weber, Heales, Malone, & Sebire, 2011).

4. Prevention Strategies for Neonatal Death-Related Medical Disputes

Given the high propensity for neonatal deaths to occur early, often within healthcare facilities, and consequently trigger disputes, comprehensive preventative strategies are essential: Enhancing Healthcare Quality and Standardization: Continuous professional development, rigorous adherence to clinical guidelines, and fostering a culture of responsibility and technical excellence among all healthcare staff are non-negotiable. Recognizing Neonatology/Obstetrics as high-risk specialties necessitates specialized training. Particular emphasis must be placed on the quality of medical documentation; all interventions, observations, and communications must be recorded objectively, comprehensively, and contemporaneously in the medical record, forming the bedrock of any future investigation or legal process (Lee, Lee, Han, et al., 2000). Mandatory, regular training and competency assessment in neonatal resuscitation (e.g., NRP) are critical for reducing preventable asphyxia-related deaths. Nursing staff must strictly implement safety protocols like identity and procedure verification to prevent errors (An et al., 2020). Pharmacotherapy demands unwavering adherence to neonatal principles, including allergy testing for sensitizing drugs and close post-administration monitoring. Strengthening Communication and Informed Consent: To counter the trust deficits arising from closed NICUs and negative media, proactive, thorough, and ongoing communication must commence at admission. This includes clear explanations of diagnoses, proposed investigations, treatment plans,

associated risks (including mortality), costs, and any changes in condition. Critically ill infants necessitate frequent updates. Any procedure carrying significant risk mandates detailed written informed consent, formally documented with signatures obtained (embodying the principle of informed consent) (Lee, Lee, Han, et al., 2000; An et al., 2020). Communication must be factual, accurate, empathetic, and use lay terminology. For complex or deteriorating cases, multidisciplinary team meetings involving senior clinicians can be invaluable. Timely recognition of institutional limitations and arranging appropriate transfer before crisis points is crucial (Lee, Lee, Han, et al., 2000). Standardizing Charging and Promoting Transparency: Strict implementation of approved fee schedules is essential, eliminating duplicate, excessive, or unwarranted charges. Providing families with daily itemized bills enhances understanding of treatments and associated costs, fostering a transparent and standardized billing system that alleviates financial anxieties (An et al., 2020). Rational prescribing practices, avoiding both overtreatment and defensive medicine driven by litigation fears, are vital (Wang, Liu, Zhao, Butt, Yang, & Cui, 2020). Financial counselors or designated staff should be available to patiently address billing inquiries.

Fostering Legal Awareness and Self-Protection: Healthcare professionals require education on relevant legislation (e.g., Regulations on the Handling of Medical Accidents) to enhance legal literacy, ensuring their practice complies with regulations and legal procedures are meticulously followed (Liu, Zhang, Asante, Huang, Wang, & Chen, 2018). Hospitals should conduct regular legal awareness programs for all staff, empowering them with knowledge of their rights and responsibilities within the legal framework governing healthcare, thereby strengthening their ability to navigate the often adversarial medico-legal landscape and counter potentially damaging media narratives. Effective Dispute Management: Upon the emergence of a dispute, prompt escalation to senior medical and administrative personnel is imperative. Initial communication with the family should be characterized by empathy, openness, and a commitment to understanding their concerns and exploring resolution pathways. If consensus remains elusive despite exhaustive efforts, pursuing a timely autopsy (ideally within the optimal postmortem window) to definitively establish the cause of death becomes a critical step for objective resolution (Pryce, Weber, Heales, Malone, & Sebire, 2011).

5. Conclusion

The rising trend in neonatal death-related medical disputes, driven by complex interactions between leading causes of death (asphyxia, respiratory diseases, malformations, intracranial pathologies), healthcare system factors (technical skill gaps, communication failures, high costs), and socio-cultural dynamics, necessitates robust institutional responses. Hospitals must implement comprehensive management systems specifically targeting these high-risk areas. Continuous quality improvement initiatives focused on sensitive factors like resuscitation skills, infection control, prenatal diagnosis, communication protocols, and financial transparency are paramount. Proactive risk management, rigorous adherence to standards, and a genuine commitment to patient safety and family-centered

communication are fundamental to preventing adverse events and fostering collaborative, rather than adversarial, relationships with families experiencing the tragedy of neonatal loss. Forensic pathology remains indispensable for elucidating the truth in disputed cases, yet significant challenges persist, particularly in refining diagnostic criteria for conditions like asphyxia and interpreting complex findings in the context of neonatal vulnerability. Further research integrating clinical, pathological, and epidemiological perspectives is crucial to advance forensic practice, enhance dispute resolution mechanisms, and ultimately contribute to reducing preventable neonatal mortality and the associated human and systemic costs of medical conflict.

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