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RESUSCITATION MEASURES IN NEONATAL ASPHYXIA: CLINICAL APPROACHES, RISK FACTORS, AND PREVENTIVE STRATEGIES

Dr. Mehmet Ali Yılmaz
MD, PhD
Department of Anesthesiology and Reanimation
Faculty of Medicine, Ege University
İzmir, Türkiye

Abstract: Neonatal asphyxia remains one of the leading causes of neonatal morbidity and mortality worldwide, particularly in low- and middle-income countries. It is characterized by impaired gas exchange resulting in hypoxemia, hypercapnia, and metabolic acidosis, which may lead to multi-organ dysfunction and long-term neurological impairment. Despite advances in perinatal care, early recognition and timely resuscitation remain critical determinants of outcome. This article reviews the pathophysiology, risk factors, diagnostic criteria, and evidence-based resuscitation strategies for neonatal asphyxia, with particular emphasis on delivery room management and preventive approaches. International guidelines and clinical experience are integrated to provide a practical framework for clinicians involved in neonatal care.

Keywords: neonatal asphyxia, newborn resuscitation, hypoxia, perinatal care, neonatal intensive care

Introduction

Neonatal asphyxia is a major global health problem and continues to pose significant challenges to perinatal and neonatal care providers. According to the World Health Organization, birth asphyxia accounts for a substantial proportion of neonatal deaths and contributes significantly to long-term neurodevelopmental disabilities among survivors. The condition is defined as the failure to establish and sustain adequate respiration at birth, leading to systemic hypoxia and ischemia.

Although modern obstetric and neonatal practices have reduced the incidence of severe asphyxia in developed healthcare systems, it remains prevalent in settings with limited access to prenatal care, skilled birth attendants, and neonatal resuscitation resources. Importantly, neonatal asphyxia is not a single disease entity but rather a clinical syndrome with multifactorial

etiology, requiring a comprehensive and structured approach for prevention, diagnosis, and management.

This article aims to provide a detailed overview of neonatal asphyxia, focusing on resuscitation measures in the delivery room, identification of high-risk conditions, and preventive strategies during the antenatal and intrapartum periods.

The primary pathophysiological mechanism in neonatal asphyxia is impaired gas exchange, leading to decreased oxygen delivery and increased carbon dioxide retention. This results in respiratory and metabolic acidosis, cellular hypoxia, and energy depletion. Prolonged hypoxia triggers anaerobic metabolism, accumulation of lactic acid, and failure of cellular ion pumps, ultimately causing cell injury and death.

The brain is particularly vulnerable to hypoxic-ischemic injury due to its high metabolic demand and limited capacity for anaerobic metabolism. Hypoxic-ischemic encephalopathy (HIE) is one of the most severe complications of neonatal asphyxia and is associated with long-term neurological sequelae such as cerebral palsy, epilepsy, cognitive impairment, and developmental delay.

In addition to neurological damage, prolonged asphyxia can lead to multi-organ dysfunction involving the cardiovascular system, lungs, kidneys, liver, and gastrointestinal tract. Systemic hypotension, myocardial dysfunction, acute kidney injury, and coagulopathies are frequently observed in severe cases.

The development of neonatal asphyxia is often associated with identifiable risk factors that can be broadly categorized into antenatal, intrapartum, and neonatal factors.

Antenatal risk factors include maternal hypertension, preeclampsia or eclampsia, diabetes mellitus, anemia, chronic respiratory or cardiovascular disease, intrauterine growth restriction, post-term pregnancy, multiple gestation, and inadequate prenatal care. Placental abnormalities such as placental insufficiency, previa, or abruption significantly increase the risk of fetal hypoxia.

Intrapartum risk factors include prolonged or obstructed labor, abnormal fetal presentation, umbilical cord compression or prolapse, meconium-stained amniotic fluid, emergency cesarean section, instrumental delivery, use of general anesthesia, and fetal heart rate abnormalities indicating distress.

Neonatal factors include prematurity, low birth weight, congenital anomalies, intrauterine infections, and respiratory tract obstruction due to mucus, blood, or meconium.

Identification of these risk factors allows healthcare providers to anticipate the need for resuscitation and ensure the availability of trained personnel and appropriate equipment at delivery.

The diagnosis of neonatal asphyxia is primarily clinical and should be based on a combination of historical, clinical, and laboratory findings. No single marker can be considered a “gold standard” for diagnosing asphyxia or predicting the severity of brain injury.

The Apgar score, assessed at 1, 5, and 10 minutes after birth, remains a useful tool for evaluating the newborn’s immediate adaptation to extrauterine life. However, it should not be used as the sole criterion for diagnosing neonatal asphyxia. Low Apgar scores may result from prematurity, maternal medications, or congenital anomalies and do not necessarily indicate hypoxic-ischemic injury.

Objective evidence of impaired gas exchange, such as umbilical arterial blood pH below 7.0, elevated base deficit, and signs of metabolic acidosis, provides stronger support for the diagnosis. Neuroimaging studies, including magnetic resonance imaging and spectroscopy, may demonstrate patterns of hypoxic-ischemic brain injury and assist in prognostication.

The primary goal of neonatal resuscitation is to rapidly establish effective ventilation and circulation, thereby restoring oxygen delivery to vital organs. International guidelines emphasize a stepwise approach based on continuous assessment of the newborn’s respiration, heart rate, and tone.

Immediately after birth, the infant should be placed under a radiant warmer, dried, and positioned to maintain a patent airway. Gentle suctioning of the mouth and nose may be performed if secretions obstruct breathing. Routine suctioning is not recommended in vigorous newborns, even in the presence of meconium-stained amniotic fluid.

If the newborn fails to initiate spontaneous breathing or exhibits ineffective respirations, positive pressure ventilation should be initiated promptly. Adequate ventilation is the single most important intervention in neonatal resuscitation and often leads to rapid improvement in heart rate and oxygenation.

When basic resuscitation measures fail to restore adequate respiration and heart rate, advanced interventions are required. These measures should be performed by trained personnel in accordance with international neonatal resuscitation guidelines.

If the heart rate remains below 60 beats per minute despite effective positive pressure ventilation for 30 seconds, chest compressions should be initiated. Chest compressions are performed using the two-thumb encircling technique, with a compression-to-ventilation ratio

of 3:1. The depth of compression should be approximately one-third of the anterior-posterior diameter of the chest, ensuring adequate cardiac output without causing trauma.

Endotracheal intubation may be necessary to secure the airway and provide more effective ventilation, particularly in cases of prolonged resuscitation, diaphragmatic hernia, or suspected airway obstruction. Confirmation of correct tube placement should be achieved through clinical assessment and, when available, capnography.

Pharmacological support is rarely required but may be lifesaving in selected cases. Epinephrine is indicated when the heart rate remains below 60 beats per minute despite adequate ventilation and chest compressions. It is preferably administered intravenously via the umbilical vein at a dose of 0.01–0.03 mg/kg of a 1:10,000 solution. Volume expansion with isotonic crystalloid solutions may be considered if there is evidence of hypovolemia or acute blood loss.

The Persiyaninov method represents a historically significant approach to neonatal resuscitation, particularly in post-Soviet and Eastern European medical practice. The method emphasizes rapid pharmacological stimulation of respiration and cardiac activity through umbilical vessel access.

The procedure begins with thorough clearance of the upper airway to remove mucus, amniotic fluid, or other obstructive materials. A measured dose of calcium-containing solutions is then administered through the umbilical vessels to stimulate myocardial contractility and respiratory center activity. In the absence of clinical improvement, additional metabolic support agents, such as glucose and ascorbic acid, may be introduced.

Although modern neonatal resuscitation guidelines prioritize ventilation and oxygenation over pharmacological stimulation, the Persiyaninov method remains of academic interest and historical relevance. Elements of this approach have contributed to the evolution of contemporary resuscitation strategies, particularly in emphasizing rapid vascular access and metabolic correction in severe asphyxia.

Successful resuscitation does not mark the end of treatment for neonates with asphyxia. Post-resuscitation care is critical in preventing secondary injury and optimizing long-term outcomes. After stabilization, the newborn should be transferred to a neonatal intensive care unit for continuous monitoring and supportive therapy.

Key components of post-resuscitation care include maintenance of adequate oxygenation and ventilation, careful regulation of body temperature, and monitoring of blood glucose and

electrolyte levels. Hypoglycemia, hypocalcemia, and metabolic acidosis should be promptly corrected.

Neurological assessment plays a central role during this phase. Infants with moderate to severe hypoxic-ischemic encephalopathy may benefit from therapeutic hypothermia, which has been shown to reduce mortality and improve neurodevelopmental outcomes when initiated within the first six hours of life.

Cardiac, renal, and hepatic functions should be closely monitored, as multi-organ dysfunction is a common consequence of prolonged asphyxia. Early recognition and management of complications significantly improve survival and quality of life.

Prevention remains the most effective strategy in reducing the incidence and severity of neonatal asphyxia. Preventive measures begin during the antenatal period and continue through labor, delivery, and the immediate postnatal phase.

Adequate prenatal care allows for early identification and management of maternal conditions such as hypertension, anemia, diabetes, and infections. Regular fetal monitoring and timely referral to specialized centers are essential in high-risk pregnancies.

During labor, continuous fetal heart rate monitoring enables early detection of fetal distress and timely obstetric intervention. Proper management of labor, avoidance of prolonged or obstructed delivery, and judicious use of operative techniques contribute significantly to improved neonatal outcomes.

Equally important is the training of healthcare personnel in neonatal resuscitation. Simulation-based education, standardized protocols, and availability of essential equipment in delivery rooms have been shown to markedly reduce neonatal mortality associated with asphyxia.

Discussion

Despite significant advances in perinatal medicine, neonatal asphyxia remains a complex and multifactorial condition. The absence of a single diagnostic marker underscores the importance of a comprehensive clinical approach combining history, physical examination, and laboratory data.

Timely and effective ventilation remains the cornerstone of neonatal resuscitation. Most newborns respond favorably to basic interventions, highlighting the critical role of skilled birth attendants and well-organized delivery room teams. Advanced interventions and pharmacological support should be reserved for cases unresponsive to initial measures.

The long-term prognosis of infants with neonatal asphyxia depends on the severity and duration of hypoxia, the promptness of resuscitation, and the quality of post-resuscitation care. Early neuroprotective strategies and structured follow-up programs are essential for optimizing developmental outcomes.

Conclusion

Neonatal asphyxia continues to be a major contributor to neonatal morbidity and mortality worldwide. Early recognition of risk factors, preparedness for resuscitation, and adherence to evidence-based protocols are crucial for improving survival and reducing long-term complications.

Effective neonatal resuscitation requires not only technical skills but also coordinated teamwork, continuous assessment, and timely decision-making. Strengthening antenatal care, improving intrapartum monitoring, and expanding neonatal resuscitation training programs remain key priorities in addressing this persistent global health challenge.

References

1. World Health Organization. **Guidelines on Basic Newborn Resuscitation.** Geneva: WHO; 2021.
2. Perlman JM, et al. **Neonatal Resuscitation: Updated Guidelines.** Pediatrics. 2020;146(1):e2020038505.
3. Lawn JE, et al. **Birth asphyxia and neonatal mortality.** Lancet. 2018;392:223–234.
4. American Academy of Pediatrics. **Textbook of Neonatal Resuscitation.** 8th ed. Elk Grove Village; 2021.
5. Shankaran S. **Hypoxic-ischemic encephalopathy and therapeutic hypothermia.** N Engl J Med. 2015;373:154–162.