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Neonatal resuscitation, management of maternal complications, and care during space missions

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Abstract

Neonatal resuscitation and maternal care in space present unique challenges that necessitate meticulous planning and precise execution. This article provides a comprehensive plan for neonatal resuscitation, addressing critical steps such as immediate care, evaluation, and potential complications. It also covers the management of maternal complications, including infection control and treatment of postpartum hemorrhage. The procedures discussed include immediate drying, suctioning secretions, evaluating vital signs, providing positive pressure ventilation (PPV), and administering medications as needed. Additionally, the article discusses the management of neonatal and maternal complications and post-resuscitation care, emphasizing the importance of hygiene and infection prevention in the space environment.

Keywords: Space; Childbirth; Multi-planet; Pioneering; Midwifery; Ethics

1. Introduction

The birth of a neonate and the management of maternal complications during space missions introduce a range of challenges that require well-defined protocols and training. Given the unique environment of space, it is crucial to have a detailed plan for immediate and effective neonatal resuscitation and maternal care to ensure the survival and health of both mother and newborn. This article outlines the essential steps and considerations for neonatal resuscitation, maternal care, and the management of complications during space missions.

2. Neonatal Resuscitation Procedures

2.1. Immediate Drying and Warming

- Immediately dry the baby under a warmer.
- Change the wet towel with a dry one to maintain warmth.

2.2. Suctioning Secretions

- Suction secretions using POAR (Positive Airway Resuscitation) to clear the airway.

2.3. Evaluation of the Newborn

- Assess the baby's breathing, heartbeat, and color to determine the need for further interventions.

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2.4. Stimulation

- Apply soft strokes to the soles of the feet and gently massage the spine to stimulate breathing.

2.5. Positive Pressure Ventilation (PPV)

- Use an Ambu bag and mask to provide PPV if the baby is not breathing adequately.

2.6. Heart Rate Assessment

- Check the baby's heart rate:
    - If the heart rate is less than 80 beats per minute, perform chest compressions (one breath for every three compressions).
    - If the heart rate is above 80, stop compressions and continue to monitor breathing and color.

2.7. Medication Administration

- Administer epinephrine (0.1-0.3 cc/kg) via tracheal tube or umbilical catheter if necessary. Re-injections can be done every 5 minutes up to three times in a 3 kg neonate.
- Address potential causes if there is no response to epinephrine:
    - Treat respiratory acidosis with ventilation.
    - Treat metabolic acidosis with sodium bicarbonate (1 mEq/kg) injected in the umbilical vein.
    - Treat hypovolemia with FFP, 5% albumin, or normal saline.
    - Prolonged asphyxia may require dopamine (250+5-15 cc of serum).

2.8. Glucose Administration

- Provide glucose to support energy needs and correct hypoglycemia (initial dose of 200 mg/kg of 10% solution, followed by 8-4 mg/kg).

2.9. NG Tube Placement

- Place a nasogastric (NG) tube if ventilation with an Ambu bag exceeds two minutes.

2.10. Intratracheal Intubation

- Perform intubation if resuscitation is prolonged or mask ventilation is ineffective.

3. Management of Maternal Complications

3.1. Infection

Space environments can increase the risk of antibiotic-resistant bacteria and reduced immune function, making hygiene crucial. Some microorganisms become more aggressive in microgravity, and during childbirth, feces, secretions, and blood can spread, posing risks to other astronauts.

3.1.1. Actions to Prevent Infection

- **Temperature Monitoring:** Monitor the mother's temperature for the first 24 hours post-delivery to detect fever.
- **Antibiotic Prophylaxis:** Administer a single dose of appropriate antibiotics around childbirth.
- **Sterile Tools:** Use sterile tools and equipment during childbirth.

3.1.2. Risk Factors for Infection

- Preventable: Young maternal age, nulliparity, maternal obesity, multiple vaginal examinations, previous genital tract infections.
- Non-preventable: Long labor, meconium-stained fluid, chorioamnionitis, rupture of membranes, potential cesarean section.

3.2. Vaginal Bleeding

Postpartum hemorrhage (PPH) is defined as bleeding exceeding 500 ml after vaginal delivery or 1000 ml after cesarean section. It can be early (within 24 hours) or late (after 24 hours).

3.2.1. Primary Treatment Measures

- Monitor vital signs until bleeding is controlled and hemodynamic stability is achieved.
- Ensure two suitable IV lines are in place.
- Conduct CBC, PT, and PTT tests.
- Reserve two units of packed cells or whole blood and fresh frozen plasma (FFP).
- Insert a Foley catheter and monitor intake/output if bleeding is severe.
- Compensate for blood loss with fluid therapy (3 cc of fluid for every 1 cc of blood lost).
- Administer blood if necessary, maintaining blood pressure and urinary output.
- Monitor the mother during blood transfusion.
- Provide oxygen via mask or nasal cannula (4-2 L/min).

3.2.2. Secondary Treatment Measures

Diagnose the cause of bleeding and take appropriate action.

- Post-Resuscitation Care and Monitoring

Kangaroo Mother Care (KMC)

- Use KMC to maintain the baby's temperature and provide comfort. The mother-astronaut should perform KMC during the return to Earth.

Vital Signs Monitoring

- Monitor the neonate's temperature, blood sugar, heart rate, and respiratory rate regularly.
- Check for any signs of hypothermia, hyperthermia, bradycardia, tachycardia, tachypnea, bradypnea, apnea, nasal flaring, and grunting.

Skin Color and Muscle Tone Assessment:

- Assess the neonate's skin color for signs of icterus, acrocyanosis, and general cyanosis.
- Evaluate muscle tone and perform the Moro reflex test.

Umbilical Cord Care

- Inspect the umbilical cord for two arteries and one vein, and ensure proper care to prevent infection.

Feeding Readiness:

- Test the infant's sucking reflex and check for any cleft lip or palate before starting feeding.

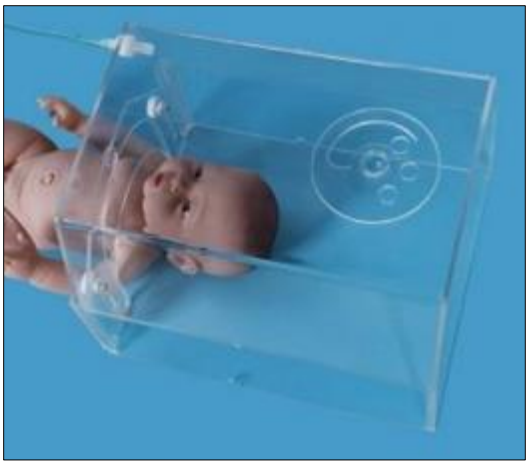
Urinary and Bowel Function Monitoring:

- Ensure the neonate has passed urine within 24 hours and stool within 48 hours after birth. If not, further examinations are required.

4. Neonate Breathing in Space

4.1. Assumption and Preparation:

- Assume the neonate born at term has mature lungs but be prepared for potential breathing issues.
- Use an oxy-hood with a controlled oxygen mixture to assist with breathing if needed.



Infant Oxygen Hood [Internet]. Available from: https://m.aliexpress. com/i/3256801528245531.html? gatewayAdapt=Pc2Msite4itemAdapt

Figure 1 Oxy-hood

Network HN. Kangaroo Mother Care

Mother-astronaut does KMC (kangaroo-mother-care), and in the same position, she returns the neonate to earth (Figure 2).

Figure 2 KMC

5. Conclusion

Effective neonatal resuscitation and maternal care during space missions require meticulous planning and precise execution. By following the outlined procedures, including immediate care, evaluation, medication administration, and post-resuscitation monitoring, the health and survival of both mother and neonate can be ensured. As humanity continues to explore space, these protocols will be essential for addressing the unique challenges of neonatal and maternal care in a microgravity environment

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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