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NEONATAL TRANSPORT: WHEN AND HOW?

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Review

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Abstract

Neonatal transport is one of the critical processes of the neonatal care. It is the transfer of the critically sick newborn to an advanced health care center for further evaluation, treatment and follow up. The morbidity and mortality of the ill newborn is associated with the transport conditions and caregiving during the transfer strongly. In Turkey, the transport of the ill newborn is provided by 112 Emergency Medical Teams under the control of General Directorate of Emergency Health Services, the Health Ministry of the Turkish Republic. In this review, we will focus on three directional transport of the newborn which means transporting patients by regional emergency transport system (112) by ground ambulances and which is the most commonly used way in our country with some recommendations to improve the process by local precautions.

Keywords: Emergency transport team, Neonatal transport, Precaution

Özet

Yenidoğan nakli yenidoğan bakımının en kritik bileşenlerinden biridir. Hasta yenidoğanların ileri değerlendirme, tedavi ve takip amacı ile ileri merkezlere yönlendirilmesi olarak tanımlanır. Sevk edilen bebeğin morbidite ve mortalitesi nakil koşulları ve nakil sırasında verilen bakımla yakından ilgilidir. Türkiye'de yenidoğan nakli T.C. Sağlık Bakanlığı, Acil Sağlık Hizmetleri Genel Müdürlüğü' ne bağlı yerel 112 ekipleri tarafından gerçekleştirilmektedir. Bu derlemede yerel 112 ekipleri tarafından kara ambulansı yoluyla gerçekleştirilen yenidoğan sevklerine odaklanıp hizmetin iyileştirilmesine yönelik olarak alınabilecek yerel önlemlerle öneriler gözden geçirilecektir.

Anahtar kelimeler: Acil nakil ekibi, Yenidoğan nakli, Önlemler

1. Introduction

Neonatal transport is one of the critical processes of the neonatal care. It is the transfer of the critically sick newborn to an advanced health care center for further evaluation, treatment and follow up (Öztürk, 2007). In fact, the safest way of neonatal transport is in utero transfer for the sake of the newborn. However, this may be impossible because of some inevitable and unpredictable clinical conditions, including perinatal problems, premature labor, congenital malformations or sometimes the health care center may not be appropriate for the medical demands of the newborn (Dilli D, 2024; Narlı et al., 2018). The morbidity and mortality of the ill newborn is associated with the transport conditions and caregiving during the departure strongly (Narlı et al., 2018). The goal of the transport team is to provide neonatal intensive care (NICU) conditions so that the treatment and follow up of the baby is not disrupted till the arrival of destination (Narlı et al.,2018; Öztürk, 2007).

In Turkey, emergency medicine is carried out by Anglo-American model, which is staffed by paramedics and/ or emergency medical technicians and implemented rapid patient transport to the hospital, where physicians provide care in the emergency department (Al-Shaqsi, 2010). The transport of the ill newborn is provided by 112 Emergency Medical Teams under the control of General Directorate of Emergency Health Services, the Health Ministry of the Turkish Republic. "The Newborn Transfer and Transport Form" and formal guidelines about implementation procedures and principles of prehospital, interhospital and interprovincial patient transport

services are present (Health Ministry of the Turkish Republic, 2024). Turkish Neonatal Society and formal health authorities of our country are keen on improving the neonatal transport services and guidelines have been prepared and updated for the safe transport of the newborn (Narlı, 2018) . These efforts are important to reduce the infant mortality rates which is one of the significant determinants of healthcare sophistication (Kavuncuoğlu et al., 2014). In this review we will focus on three directional transport of the newborn which means transporting patients by regional emergency transport system (112) by ground ambulances and which is the most commonly used way in our country.

2. Neonatal Transport

The indications of neonatal transport are not clear, but the decision of transport depends on the level and facilities of the NICU of the healthcare institution where the delivery takes place and the medical status of the newborn. Any disease, requiring intensive care or complex treatment beyond the facilities of the delivery hospital makes the transfer necessary. The NICU levels and their patient acceptance criteria are defined formally (Narlı, 2018; Cumhurbaşkanlığı Mevzuat Bilgi Sistemi, 2024). However, the contraindications of transport are defined clearly: Congenital anomalies incompatible with life, non- viable infants (<400g and <23th week of gestational age), infants who cannot be stabilized and predicted to die during transport and inappropriate transport conditions (Narlı, 2018).

Regional emergency medical services: phone call (On-Call) system - Emergency center call (112 for our country) organize the transport of critically ill patients, including the neonates. The clinician serving the newborn decides the necessity of transport for the sick baby demanding advanced facilities because of unfavorable medical conditions. The demand for transport is sent to the 112-call center online via form containing the identity and medical information about the patient. The center investigates the suitable NICU for the baby and provides direct communication between the referring and accepting clinicians. Before transfer, the stabilization of the neonate is provided and precautions are taken against anticipated risks during the transfer. The stabilized patient is delivered to the transport team which is usually consist of two emergency medical technicians or paramedics and a driver. In fact, a physician, an expert on neonatal problems, should be a member of this team, but it is usually impossible in our conditions. During the cruise,

the ambulance staff and referring clinician stay in contact about the patient and transport ends when the neonate reaches the NICU accepting the baby (Narlı et al., 2018).

The medical condition of the patient, geographic and weather conditions, the distance between the two hospitals and family consent determine the way of transport. Neonatal transports between hospitals are usually take place by ground ambulances. Air transport systems are also available for specialized cases; but not that widespread and cost effective as much as overland route. There is no specialized organization or standard procedural guidelines for neonatal transport, usually institutional or personal practices are the routers of the process (Uslu et al., 2017). Although the distance thresholds may differ from country to country, helicopter can be considered for distances of 80-240 km and airplane for 240 km and over. In addition, the organization and procedures are different in airline transport (Kilpatrick SJ, 2017;Narlı et al., 2018).

Neonatal transport is a team work. The team members are expected to be able to evaluate the medical status of the sick newborn and perform all emergent procedures when necessary. However, in our country, most of the teams are standard and not specialized for neonatal transport. Neonatal resuscitation programs (NRP) and transport educations are organized for 112 transport staff, but these efforts should spread to whole country under the control and organization of local health authorities which make the process easier, more time and cost effective than central organizations because the trainees may have difficulty to travel to other cities and stay there for some days (Narlı et al., 2018).

3. Materials and Drugs during the Neonatal Transport

It is recommended to use a separate ambulance and equipment for neonatal transport. All the equipment should be designed for neonates and all members of the transport team should be educated well to use the devices appropriately. That's why local in-service training should be organized periodically to improve the quality of transport and care because equipment and facilities vary from center to center (Narlı, 2018).

Transport incubator is necessary for the process; the incubator should be compatible with the cabin and power supply of the ambulance. Heat control is provided by the incubator. Soft, flexible probes should be used for skin measurements. The baby should be inspected appropriately by

the team and when necessary, the health care personnel should be able to reach the baby from two sides. Locking system is also important (Narlı et al., 2018).

A ventilator can be mounted to the incubator. Ventilators should be portable, durable, and easy-to-use. Ventilators pressure-limited, time-cycled with synchronized mode should be preferred. Aspirators also are necessary (Narlı, 2018).

The patient should be monitored during the whole transport. The probes of the monitors should be compatible with the neonates and alarm limits should be arranged to the neonatal rates. Cardiac rate and rhythm, oxygen saturation, blood pressure should be monitored continuously and recorded periodically. The devices should resist to movement and vibrations during the trip so that erroneous measurements can be prevented (Narlı, 2017).

Parenteral infusion pumps that can infuse 0.1ml/h and have the ability to stand without a support and function without power supply when necessary (Narlı, 2018).

Neonatal transport bag: Unless the ambulances are specific for neonatal transport and have the necessary materials on the shelves, a transport bag containing neonatal routine and intensive care equipment should be prepared. Technical equipment should be checked and calibrated before and after every transport. Monitors, probes, power supply materials, infusion pumps should be clean and ready for use (Narlı, 2018). In addition, all drugs that can be necessary during the cruise should be prepared by consulting the referring physician. Appropriate storage and safe preparation of the drugs are important. Usually 0.9% NaCl and 5%-10% dextrose fluids are used for drug preparation and treatment. Resuscitation and stabilization drugs such as Adrenaline, Dopamine, Dobutamine, Prostaglandin E1 should be stored appropriately with practical charts describing preparation and dosage due to baby's weight (Narlı, 2011). The compatibility of drugs and contraindication should be schematized

4. Stabilization of the Patient

Before transport, the neonate should be stable medically and prepared legally. Newborns who cannot be stabilized or who have not been confirmed by the accepting center must not depart (Narlı, 2018). The referring physician should have evaluated the patient and administered the initial treatment. The medical history and information about medical inventions should be given to the accepting physician verbally and in written epicrisis report. During the cruise the transport team and the referring physician should be in contact for the sake of the patient (Narlı et al., 2018).

Tele-consultation, a form of telemedicine, is useful for this process. Visual telephone calls via internet sources facilitate the procedure (American Telemedicine Association, 2024). Stabilization steps before transport are summarized in Table 1.

Table 1. Stabilization Criteria and Directions to Provide (modified from the references: Narlı, 2011; Narlı, 2017; Narlı 2018; Narlı et al., 2018)

Stabilization criteria: 5H: HYPOTHERMIA: Thermoregulation
What to do and why? 1. Body temperature of the neonate should be kept at 36.5 -37.5°C (exception: hypoxemic neonates needing hypothermia treatment). 2. Temperature monitoring should be enabled with a power-controlled system by placing heat sensor on the baby's skin. 3. Newborns are vulnerable to cold and hypothermia in infants is an important risk factor that has a negative effect on mortality and morbidity. It reduces response to applied treatments and causes metabolic corruption. **How?** 1. The ambulance cabin and transport incubator should have proper temperature and humidity. 2. The baby should wear a cap. 3. Preterm babies born before 32 weeks of gestation age and birth weight of <1000g should be put in plastic bags to protect heat and humidity loss. 4. Kangaroo method can be a choice under inappropriate circumstances.
Stabilization criteria 5H: HYPERCARBIA/ HYPOCARBIA. Respiration
What to do and why? 1. The rate of respiration in neonates is 40-60/min. 2. Spontaneous respiration should be under control providing the target levels of oxygen saturation or adequate airway should be provided non-invasively or invasively.

3. Tachypnea, groaning, intercostal and subcostal retractions, apnea, desaturation are the signs of respiratory insufficiency and may result in respiratory failure.

How?

1. Respiratory support should be planned appropriately estimating the departure conditions.
2. Clinical signs of respiratory distress, blood gases, pulse oximetry, and chest radiography should be evaluated in holistic point of view.
3. Nasal CPAP through nasal cannula or intubation should be provided if necessary.
4. Intubation indications before transport: Clinical instability, required FiO2 >50% to keep the saturation is above 90-94%, signs of respiratory distress, high pCO2, recurrent apnea, gestational age <30 GH.
5. If the patient is intubated, the tube should be fixed properly and the upper lip level should be recorded because of risk of displacement during the transport.
6. Intubation should be performed with sedation (narcotic or benzodiazepine) after premedication. Fentanyl (1-2 μg /kg) or midazolam (0.05- 0.1 mg/kg) may be given for analgesia and sedation.

Stabilization criteria **5H: HYPOXIA/ HYPEROXIA, Oxygenation**

What to do and why?

The O2 saturation should be 90-94% and measured preductally (right wrist)

How?

1. Adjustment of ventilator parameters should be made before transport providing the following values: pH 7.25–7.4, pCO2 30-45 mmHg, and PaO2 45- 75 mmHg.
2. To prevent the endotracheal tube obstruction by secretions, the tube should be aspirated internally when indicated.

Stabilization criteria **5H: HYPOTENSION, Circulation**

What to do and why?

1. Heart rate of neonates is 120-160/min and capillary filling time, a marker of tissue perfusion, should be <3 s).
2. In practice, the value of gestational age is thought to be the mean blood pressure.

How?

1. Hypotension should be healed before transport (by giving volume expander agents (usually % 0.9 NaCl at a dosage of 10-20 mL/kg in 30-60 minutes).
2. If there is no enough response to volume expanders, inotropic agents should be applied.
3. If indicated, transfusion of blood products should be completed before departure.

Stabilization criteria 5H: HYPOGLYCEMIA, Fluid-electrolyte-nutrition, metabolic balance

What to do and why?

1. At least one usable intravascular access in all patients should be provided. Neonates with complicated problems should have one central access or 2 two intravascular accesses
2. Metabolic imbalances should be treated before transport.
3. Protection from acidosis (blood pH >7.25-7.40) and hypo-hyperglycemia (blood glucose level 50-120 mg/dL, hypocalcaemia are important.

How?

1. Fluid containing dextrose at a dose of 60-80mL/kg and concentration providing normoglycemia (50-120 mg/dl) should be given on the first day of life according to the gestational age and medical status.
2. After the first 24 hours, the amount and content of the fluid should be administered due to the postnatal day, weight, and clinical condition.
3. Enteral feeding should be discontinued and a nasogastric-orogastric tube should be placed and drained when the patient has abdominal distension, tenderness or discoloration.
4. Intubated patients or babies having CPAP with nasal cannula should have orogastric tube to prevent gastric distension.

Stabilization criteria Legal procedures and consent, Family support

What to do and why?

1. Confirmation of identity and gender is obligatory. The "Informed Consent and Approval Document" should have been read, filled and signed by at least one of the parents or legal conservator.
2. Participation of relatives other than the parents in the transport process should be prevented.

How?

1. The information about the identity and medical history of the patient should be recorded and a written form should be prepared for the accepting center.
2. The parents should be able to see their baby in the NICU before transport.
3. Emotional support without too much optimism or pessimism is important.
4. Healthcare personnel should be sensitive about the family's difficulties and emotions.

The emergent problems that can be met during transport are called "5Hs" which are: *Hypothermia, Hypoglycemia, Hypotension, Hypoxia/ Hyperoxia, Hypercarbia/ Hypocarbia.* The precautions of these problems are pointed in Table 1 (Narlı, 2011; Narlı, 2017; Narlı, 2018; Narlı et al., 2018). All neonates should be evaluated and treated for these problems. However, there are some rare, but significant situations demanding additional precautions. Some of them are summarized in Table 2 (Narlı N, 2018; N. Narlı et al., 2018). Transport of newborns needing advanced supportive treatment such as high-frequency oscillatory ventilation (HFOV) and inhaled nitric oxide (iNO) or extracorporeal membrane oxygenator (ECMO) should be given birth in specific central hospitals after prenatal transport.

Table 2. Exceptional Clinical Problems and Precautions (modified from references (Dilli D, 2024; Narlı, 2018; N. Narlı et al., 2018)

Clinical problem	**Precautions**
(The conditions mentioned in Table 1 should be provided first, these checklist items are added on them).	
Prematurity **Low birth weight infants**	1. Avoid hypothermia:

- Chemical gel packs and polyethylene plastic sheets can also be used.
- The transfer of the infant from hospital incubator to transport incubator should not exceed 15 sec.
- The windows of the incubator should not be opened unless absolutely necessary

2. Provide adequate humidity: The humidity unit of the ventilator should be active, the windows of the incubator should be kept closed, and its damping valve should be opened.
3. Noise and vibrations during departure should be minimum.
4. Tracheal aspiration should not be performed up to six hours after administration of surfactant, if possible
5. Appropriate sedation should be ensured in all intubated infants. There is no routine indication for muscle relaxants for transport.

Hypoxic ischemic encephalopathy

1. Hypothermia treatment is effective when initiated within the first six hours (Stafford et al.,2017). Passive hypothermia which should have been applied in the NICU should continue during the transport by closing the heating system and opening the windows of the incubator.
2. The target rectal temperature is 33-34°C and a follow up form should be filled during the trip

Pneumothorax

1. If pneumothorax causes hemodynamic instability, the trapped air in the thorax should be drained by needle aspiration.
2. In case of clinical suspicion transillumination of the chest is a rapid examination method. X- ray assessment of the chest provides definite diagnose
3. The transport should be interrupted and continue after stabilization.

Necrotizing enterocolitis

Intravenous fluid, broad spectrum antibiotic treatment, correction of metabolic problems and gastric decompression should continue during the transport

Congenital diaphragm hernia

1. Tracheal intubation should be performed before transport. Positive pressured ventilation (PPV) is contraindicated
2. A wide nasogastric or orogastric tube should be placed for gastric decompression and continuous aspiration.

Esophageal atresia and tracheo-esophageal fistula

1. Orogastric tube should be placed for continuous aspiration of the proximal esophageal pouch during transport
2. Supine position should be given by elevating the head side of the bed.
3. PPV should be avoided.

Abdominal wall defects

1. These infants have the risk of hypothermia, dehydration and hypoglycemia
2. The lower part of the trunk including the intestines should be wrapped with a colostomy bag.
3. The baby should be transported in the lateral position by supporting the exposed intestines to prevent stretching and bending which may result in ischemia..
4. An orogastric tube should be placed during transport.
5. Umbilical catheterization should be avoided

Neural tube defects

1. The baby should be in the prone position.
2. The defect should be closed by sterile and wet (0.9% NaCl) gauzes
3. Empiric broad spectrum antibiotic treatment should be considered if the tissue integrity of the defect is disrupted

Congenital heart defects (CHD).

1. The O2 support may be contraindicated in ductus dependent CHD.
2. Advanced life support should be applied before transport in cases of hypoxemia unresponsive to oxygen, congestive heart failure or shock.
3. Volume and inotropic support and correction of metabolic acidosis should continue through a safe venous access.
4. If Prostaglandin E1 (PGE1) treatment is indicated the patient should be intubated

5. Legal Procedures

It is a legal obligation to use the "Neonatal Referral and Transport Form of Health Ministry of Turkish Republic", included in Attachment-7 of the Notification about the Methods and Principles of the Intensive Care Services in Inpatient Treatment Institutions (Amendment: RG-16/8/2015-29447) during neonatal transport (Health Ministry of the Turkish Republic, 2024). The status of the newborn should be explained to the parents in simple and proper words, helping them to understand the situation. The "Informed Consent and Approval Document" should have been read, filled and signed by at least one of the parents or legal conservator (Narlı et al., 2018). The written statement of "I have read and understood" with the parent's own handwriting and signature, the name, surname, title and signature of the physician who informed the family, the interventional procedure, the date and time of the informed consent should be recorded. The Informed Consent Document should be signed as two copies. One copy should be put into the patient's file and the other copy should be given to the parent. The copy left in the healthcare institution, should have a statement establishing that one copy has been given to the parent. The document should be archived.

The written medical records should be transferred with the patient, including laboratory test results, epicrisis, copy of pregnancy records, radiologic examinations, administration of vitamin K, hepatitis B vaccine, neonatal screening sampling records and if necessary, cord and maternal blood samples (Kilpatrick SJ, 2017) .

6. After the Transport

Vital signs and clinical status of the baby should be evaluated periodically during the cruise and recorded appropriately. They should be shared with the referring and accepting physician, in addition, archived properly. The last findings before delivery to accepting NICU are also important. Scoring systems including body temperature, heart and breathing rate, blood pressure and evaluating awareness can be used (Lee et al., 2001). A checklist can be prepared to evaluate the neonate and filled before departure and after transport (Table 3). After every transport, a meeting with the team members and commanding physician about the process should be made to notice the points that need improvement and correction.

Table 3. Checklist for pre-transport stabilization (modified from references (Dilli D, 2024; N. Narlı et al., 2018).

Identity information			
Patient's name or ID			
Name of the mother:			
Date and time of birth:			
Date and time of transport:			
Diagnose			
Referring physician, communication number			
Stabilization and Follow up Criteria		**Check sign**	
Before departure	Time:	**Delivery**	Time:
Body temperature: 36.5-37.5ºC			
Appropriate airway and ventilation (Rate: 40-60/min)			
Heart rate: 120-160/ min			
O2 saturation: 90-94%			
Blood glucose: 50-120 mg/dl			
Blood pH: 7.25-7.40			
Vascular access			
Parental consent			
Treatment during transport and notes:			

7. Conclusion, what to do?

Neonatal transport is a high-risk task needing cautious approach. The care of the sick baby during the trip should be provide as if in the NICU as far as possible. The records of the all steps and events during transport should be kept properly.In our country all hospitals and cities have different conditions and facilities of neonatal care. The organization and education of transport should be made locally because of diversity of equipment, personnel and facilities. The core training program and essentials of transport procedures should be determined by the Health Ministry. The orientation of field practitioners can be provided under the control of local

authorities. Specified teams and ambulances for neonatal transport may be organized in metropolises. These efforts can contribute to reduction in the rate of neonatal mortality.

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Conflicts of interest

None

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