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Review

Enteral and parenteral feeding of neonate

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ABSTRACT

Neonates cannot get necessary nutrients through natural ways required for growth, development, maintaining body functions healthily and renewal of the organism due to some kind of limitations. In these specific conditions, it may be necessary to use enteral or parenteral feeding method. Gestation age, birth weight, the fullness of food sources, nutritional method, the existence of growth failure and metabolic changes caused by illnesses and treatments of neonates should be taken into consideration in order to be able to choose one of these methods. Nurses who are members of a multidisciplinary team are responsible for meeting nutritional requirements of neonates. Nurses who work in the neonatal intensive care units are expected to have knowledge about nutritional requirements and feeding methods and do their practices in parallel with the evidence-based guidelines while they meet the nutritional requirements of neonates.

1. Enteral and parenteral feeding of neonate

The main aim of nutrition is to get a sufficient amount of nutrients required for growth, development, maintaining body functions healthily and renewal of the organism. (Baysal, 2004; TOBR, 2015). Feeding of the neonate is fundamentally as same as general nutrition principles, yet it also has some differences (Dağoğlu and Görak, 2008; Kültürsay et al., 2014). Whereas feeding is an effortless function for most newborn infants, babies who are at risk for or have a developmental disability often have problems in feeding. These problems can include poor intake, the excessive time needed to feed, abnormal motor patterns, an inappropriate progression of feeding skills, and physiologic compromise associated with feeding. (Ziegler et al., 2002; Maziero, 2013).

Nutritional requirement of the neonates is affected by gestational age, birth weight, the fullness of food sources, nutritional method, intrauterine growth retardation, the presence of various diseases and metabolic changes caused by treatments (Dağoğlu and Görak, 2008; Kültürsay et al., 2014). However, due to the reasons such as the quick growth process of the preterm neonates, their digestive system characteristics and the limitations in their gastrointestinal tract, it is necessary that there should be certain nutrients in their diet and these nutrients should be prepared in a certain way (Baysal, 2004).

Enteral nutrition is always the first option when there is no gastrointestinal involvement, as it inhibits the intestinal mucosa atrophy, reducing the incidence of bacterial translocation, in addition to being less expensive. However, if it is not a choice, parenteral nutrition should be used as a source of macro and micronutrient uptake or as a supplement to the enteral nutrition (Briassoulis et al., 2001; Zamberlan et al., 2011).

While feeding neonates, it should be planned for an appropriate treatment process, considering the indication of nutritional therapy, side effects, and available feeding techniques. It should be considered that the patient's clinical history, physical and laboratory assessment (especially micronutrient levels, use of drugs and gastrointestinal function (Mehta et al., 2012).

2. Energy requirements of neonate

Newborn infants with growth retardation often require an increased caloric intake for growth, because of both higher maintenance energy needs and higher energy costs of new tissue synthesis (Dağoğlu and Görak, 2008; Özek and Gökhan, 2007). The energy received by neonate should be as much as the sum of stored energy, burned energy and energy occurred by basal metabolism (Dağoğlu and Görak, 2008). Daily average calorie amount necessary for meeting essential nutrient needs, maintaining growth and development for a healthy preterm neonate is 120–130 kcal/kg while it is 100–120 kcal/kg for a term neonate. It is enough to get 150–180 ml/kg/day human milk. Neonate that cannot get human milk and is fed with formula needs to receive its energy

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40–60% from carbohydrates, 30–50% from lipids and 7–15% from protein (Bakewell-Sachs, 1999; Wyckoff et al., 2003; Özek and Gökhan, 2007; Tunçer and Özek, 2007).

3. Protein requirements of neonate

Protein is required for the synthesis of tissues and tissue repairment. In the case of inadequate calory intake, they work as a source of energy (Dağoğlu and Görak, 2008; Özek and Gökhan, 2007; Kılıçarslan Törüner and Büyükgönenç, 2012). Daily protein requirement of a healthy neonate is 3–3.5 g/kg for a preterm neonate and 2–2.5 g/kg for a term neonate (Dağoğlu and Görak, 2008). Neonates who cannot get enough protein in the first days of their life fill this deficiency by using endogenic protein sources. Thus, it is needed to keep protein/energy rate high (3g/100 kcal), particularly in preterm neonates in order to increase lean tissue mass and catch the rate of brain development and growth (Ziegler et al., 2002; Georgieff, 2005; Özek and Gökhan, 2007).

4. Carbohydrate requirements of neonate

Carbohydrate is the main source of energy. Adequate carbohydrate should be taken in a diet for use of proteins in tissue repairment, otherwise, protein is used for energy-use of protein instead of carbohydrate is undesired (Kılıçarslan Törüner and Büyükgönenç, 2012). Neonates are dependent on carbohydrates (glucose) for normal brain metabolism. Carbohydrates are the main source of energy and they are consumed in the form of monosaccharide (glucose, fructose, galactose), disaccharide (lactose, sucrose, maltose, isomaltose) and polysaccharide (starch, dextrin, glycogen, gum, fibers, cellulose) (Datta, 2014). The main glucose source in the human milk and term formulas is lactose. Although lactose activity which is needed for digestion is low in preterms smaller than 32 gestation weeks, alfa glucosidases (sucrose, maltose, isomaltose) are insufficient level. For this reason, sucrose, glucose polymers, and starch hydrolysates are used instead of lactose, partially or completely, in preterm formulas and especially in diet formulas (Tunçer and Özek, 2007).

5. Lipid requirements of neonate

Lipids are important for both utilization of lipid soluble vitamins (A, D, E, K) and development of the brain and central nervous system (Özek and Gökhan, 2007; Dağoğlu and Görak, 2008; Agostoni et al., 2010). Furthermore, they support organs and protect them. Human milk is the most suitable source of lipids and essential fatty acid (Özek and Gökhan, 2007). However, the absorption of lipids is inadequate in preterm neonates who have limited lipid sources (Denne et al., 2006). This is crucial both for the energy requirement and for thermogenesis (Özek and Gökhan, 2007).

6. Vitamin and mineral requirements of neonate

Vitamins are organic compounds that cannot be synthesized by the body yet are necessary for metabolism. Amount of water-soluble vitamins (B complex vitamins and C vitamin) depends on dietary calorie intake and the utilization of the protein and energy. The reason for the daily intake of these vitamins is to prevent their deficiency. There is no need for daily intake of lipid soluble vitamins because they may be produced from precursors in the body. Yet, vitamin supplements are given to the preterm neonates due to the possibility of not being able to meet the vitamin requirements (Denne et al., 2006; Poindexter et al., 2006).

While there is not usually any vitamin deficiency detected in healthy term neonates, iron and fluoride deficiency can be seen in neonates that only takes human milk. Thus, it is recommended that infants who take human milk should be given iron supplements during 4-6th months and fluoride after 6 months (Denne et al., 2006; Dağoğlu and Görak, 2008; Alto et al., 2013). It is also known that human milk is insufficient with respect to vitamin D. American Academy of Pediatrics recommends that term and preterm neonates who are fed with human milk should be given 400 IU/day vitamin D during the first 12 months (Dağoğlu and Görak, 2008; Özek and Gökhan, 2007; Alto et al., 2013; TOBR, 2015).

7. Enteral feeding

Enteral feeding refers to providing nutrients orally (Cup Feeding and Minimal Enteral Nutrition) or through gavage feeding (Nasogastric/Orogastric gavage and Transpyloric feeding). Gestation age of neonate, clinical state (underlying disease, nutrition requirements, gastrointestinal system state) and the ability of oral feeding are taken into consideration while choosing one of these methods (Kaempf, 1991; Denne et al., 2006; Dağoğlu and Görak, 2008; Boullata et al., 2009). Early initiation of enteral feeding, especially using breast milk, has many benefits, including reducing the need for parenteral nutrition, lowering the risk of late-onset sepsis, and reducing gastrointestinal inflammation. (Dutta et al., 2015). Furthermore, the use of a standardized feeding guideline in very low birth weight and/or very preterm neonates is associated with improvement in several clinically important outcomes (Stefanescu et al., 2016).

Oral feeding could be used in neonates who are born healthy after 34th gestation age, stable clinically (who don't have apnoea, hypothermia, tachypnoea) and have coordination in sucking and swallowing reflexes. In the cup feeding, neonates are given the opportunity to gain oral experience as the milk in the cup (cup, glass) is touched by the lips of the neonate and taken with the tongue (Kaempf, 1991; İşler, 2010). Minimal Enteral Nutrition (MEN) refers to hypocaloric and low volume enteral feeding. Neonates for whom MEN is performed can have earlier progression to complete enteral feeding, better tolerance of nutrients and earlier progression to baby bottle-mother breastfeeding (Özek and Gökhan, 2007; Dağoğlu and Görak, 2008; Kültürsay et al., 2014).

Gavage feeding, is giving nutrients to neonates who are smaller than 34th gestational age, usually hospitalized having tachypnea, can't be fed orally (anomaly in mouth, issues related to central nervous system, having swallowing disorders) intermittent or continuous from mouth or nose to the stomach by a polyethylene/polyvinyl catheter (Kaempf, 1991; Dağoğlu and Görak, 2008; Boullata et al., 2009; İşler, 2010). In the intermittent gavage feeding (bolus), nutrients are given at intervals of 2–3 h with the influence of gravity in 20–25 min and the feeding is started as 1–2 ml/kg per meal and increased depending on whether the nutrients are tolerated. In the continuous gavage feeding nutrients are provided with infusion pump in 4 h continuously or drop-by-drop (Kaempf, 1991; Denne et al., 2006; Özek and Gökhan, 2007; Dağoğlu and Görak, 2008).

While human milk is given to the neonates with the method of gavage feeding, generally continuous feeding method is applied (Dağoğlu and Görak, 2008). This method can end up with loss of lipid and protein because of the layer of fat separation. Tilting the injector to a particular angle can prevent this unfavorable situation (Boullata et al., 2009). Transpyloric feeding is providing the nutrients to duodenum or jejunum continuously in neonates who are performed nasal continuous positive airway pressure, have Nasogastric/Orogastric (NG/OG) tube intolerance, the risk for aspiration and gastric emptying problems (Kaempf, 1991; Denne et al., 2006; İşler, 2010). In this feeding method, osmotic diarrhea occurs because gastric enzymes cannot carry out digestion function which increases the loss of lipid and potassium (Dağoğlu and Görak, 2008). Besides, transpyloric feeding isn't recommended unless it is necessary since it carries risks such as intestinal perforation, peritonitis, and invagination (Kaempf, 1991; Özek and Gökhan, 2007; Tunçer and Özek, 2007; Dağoğlu and Görak, 2008; İşler, 2010).

8. Parenteral nutrition

Parenteral nutrition (PN) of which main aim is to provide energy required for metabolic reactions and growth along with positive nitrogen balance which prevents catabolism, is a vital therapeutic method which can be used in various indications (Koletzko et al., 2005; Denne et al., 2006; Özek and Gökhan, 2007; Tunçer and Özek, 2007; Dağoğlu and Görak, 2008; Kültürsay et al., 2014; Poindexter, Boullata et al., 2014). This method is frequently used in neonates who are connected to breathing device for a long time and have very low birth weight and favorable outcomes can be achieved through this method (Koletzko et al., 2005; Denne et al., 2006; Özek and Gökhan, 2007; Dağoğlu and Görak, 2008; Poindexter, Boullata et al., 2014). Parenteral nutrition may be delivered by peripheral intravenous catheters, central venous catheters or percutaneous catheters. The decision regarding which method to use should be individualized depending on the time during which the infant will be unable to tolerate enteral feeding. In general, a peripheral intravenous is likely to be adequate to maintain nutritional stores from 1 to 2 weeks, whereas a central line will support growth when a baby is expected to require parenteral nutrition for more than 2 weeks (Poindexter et al., 2006). The content of the solution used in the enteral and parenteral feeding of the neonate is important. The solution content should be prepared according to body surface area, gestation age, the ability of activity, environmental factors (radiant heater, phototherapy etc.), general status and laboratory values of the neonate. There are different amounts of recommended requirements of energy, protein, liquid, and carbohydrate for term neonate and preterm neonate. Energy, protein, minimum liquid, lipid, carbohydrate requirements recommended for term neonate are 80–90 kcal/kg/day, 100–120 ml/kg/day, 2-2.5gr/kg/day, 2.4gr/kg/day (0.5-1gr/kg/day in the first 48 h) and 10-15gr/kg/day; respectively. Energy, protein, minimum liquid, lipid, carbohydrate requirements recommended for preterm neonate are 90–100 kcal/kg/day, 2.5–3.5gr/kg/day, 120–150 ml/kg/day, 2-3.5gr/kg/day (0.5-1gr/kg/day in the first 48 h) and 10-15gr/kg/day; respectively. (Kaempf, 1991; Poindexter et al., 2006; Dağoğlu and Görak, 2008; Çelik and Yiğit, 2009). Additionally, it is recommended that sodium, magnesium, potassium, chloride, calcium, phosphor, necessary vitamins and minerals should be added to the diet. Malpractices could be seen in parenteral nutrition which aims to provide energy requirements, prevents catabolism and may meet daily requirements and growth of infant (Özekand Gökhan, 2007; Dağoğlu and Görak, 2008).

Malpractices may occur because of the different knowledge, skills, and practices in PN (Boullata et al., 2014). Although parenteral nutrition supports early metabolic demands and can be life-saving, some kind of risks such as hyperglycemia, cholestasis, and sepsis due to the possible need for a central venous catheter may occur. (Rangel et al., 2012; Embleton et al., 2014). For this reason, it requires paying utmost attention while practicing because of the potential metabolic, technical and infectious complications (Kaempf, 1991; Poindexter et al., 2006; Özek and Gökhan, 2007; Dağoğlu and Görak, 2008). In parallel with this, the World Health Organisation (WHO) promotes a systematic approach for quality improvement, minimizing the faults and ordering. It is recommended that healthcare organizations should develop evidence-based policies, procedures and practices (Kaempf, 1991; Boullata et al., 2014).

9. Role of nurses in the enteral and parenteral feeding of the neonate

Nurses are the front line for implementing care plans in the NICU. Nurses assess, plan, and provide intervention for newborns and their families in order to provide a developmentally appropriate environment, physical care, feeding, and support to parents. The role of the neonatal nurse evolves depending on the course of the baby's development in the NICU as well as on the career stage of the neonatal nurse, from beginner to experienced and advanced practitioner, including nurse managerial roles. Neonate feeding is planned and carried out with multidisciplinary teamwork in neonatal intensive care units (Maziero, 2013). Nurses, who are primary caregivers, are responsible for meeting the nutritional requirements of neonates. Nurses play an important role as a practitioner in the assessment of nutritional requirements and feeding ability of the neonate. They are an important team members of multidisciplinary team in health care services. However, it is mentioned in a study which is in qualitative and quantitative research design to identify the educational and working experiences and subsequent training needs of graduates of one course in the UK by an Advanced Neonatal Nurse Practitioner that they are not allowed to plan feeding regimes although it has been always a nurse's role. (Nicolson et al., 2005). General situation of the neonate that is fed orally should be assessed before feeding; vital signs, oxygen saturation, stress, and behavioral indicators should be monitored during the feeding process and complications should be prevented after feeding. In neonates fed with gavage, implementing OG/NG feeding tube, care of feeding tube, checking residual amount, serving recommended nutrients to the patient, predicting complications and preventing them are required. Nurses should be careful against complications which neonates may have such as distention, diarrhea, constipation, vomiting and ulceration which may occur in the tube implementation place, occlusions in the tube, displacement of the tube, aspiration, dehydration and electrolyte changes. Using aseptic technics, following PN utilization principles, paying attention to complication signs such as infection and emboli, monitoring electrolyte levels along with development and growth of the neonate are required. Nurses who work in the neonatal intensive care units are expected to have knowledge about nutritional requirements and feeding methods and do their practices in parallel with the evidence-based guidelines while they meet the nutritional requirements of neonates. Thus, it is thought that neonates can cope with diseases and their health can be protected and maintained through a multidisciplinary team approach.

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