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Derleme – Review Paper

HIGH FLOW NASAL CANNULA OXYGEN THERAPY IN PEDIATRIC PATIENTS

PEDİATRİDE YÜKSEK AKIŞLI NAZAL KANÜL OKSİJEN TEDAVİSİ

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Özet

Klinik uygulamaların yaygınlaşmasıyla birlikte oksijenin geleneksel nazal kanül yardımıyla ısıtılmasını ve nemlendirilmesini sağlayan yüksek akışlı nazal kanül kullanımına yönelik ilgi artmıştır. Yüksek akımlı nazal kanül oksijen tedavisi ile ilgili uluslararası birçok protokol bulunmaktadır. Bu derlemenin amacı pediatri servislerinde kullanılan oksijen tedavi yöntemlerinin değerlendirilmesi ve bu yöntemlerden biri olan Yüksek Akışlı Nazal Kanül Oksijen Tedavisi (YANKOT) uygulamasında hemşirelerin rol ve sorumluluklarını açıklamaktır. YANKOT'un kullanımı, tedavinin etkinliğinin gözlenmesi, çocukların YANKOT tedavisi sırasındaki izlemleri ve günlük yaşam aktivitelerinin sürdürülmesi hemşirelerin sorumluluğunda olduğundan YANKOT konusunda hemşirelik yaklaşımı önem göstermektedir.

Anahtar Kelimeler: Yüksek Akışlı Nazal Kanül Oksijen Tedavisi, Çocuk, Hemşirelik Bakımı

Abstract

With the spread of clinical applications, the interest in the use of high-flow nasal cannula, which warms and humidifies oxygen with the help of traditional nasal cannula, has increased. Many international protocols on the use of high-flow nasal cannula oxygen therapy (HFNC) are available. The aim of this review is to evaluate the oxygen therapy methods used in pediatric wards and to explain the roles and responsibilities of nurses in the application of High Flow Nasal Cannula Oxygen Therapy (HFNC). Because nurses are responsible for the use of HFNC, monitoring the effectiveness of the treatment, monitoring children during HFNC and helping them to carry out the activities of daily living, HFNC-related nursing approach is of importance.

Keywords: High Flow Nasal Cannula, Child, Nursing Care

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1. INTRODUCTION

Oxygen therapy is a life-saving medical intervention for hospitalized children (Haque et al., 2016, pp. 630-634). Oxygen was discovered by Joseph Priestly in 1774 as "dephlogisticated air". However, the widespread use of oxygen took place at the beginning of the 20th century with the pioneering work of Haldane (Heffner, 2013, pp. 18-31). Nurses regularly and independently manage oxygen therapy in the care of critically ill patients to enhance oxygen delivery and prevent the negative effects of hypoxemia (Kernick and Magarey, 2010, pp. 53-70). Oxygen administered in a timely and appropriate way is underlying to patient care and the role of a nurse. Oxygen therapy is one of the most important issues that physicians and nurses should become proficient at due to its frequent use and effects (Eastwood et al., 2009, pp. 634-641). Oxygen therapy is one of the most important issues that physicians and nurses should become proficient at due to its frequent use and effects.

Oxygen therapy is generally classified into two main groups as low-flow systems and high-flow systems (Kacmarek et al., 2019, pp. 838-878; Öztürk, 2015). A wide range of fraction of inspired oxygen (FiO_2) can be provided in both systems. The low- and high-flow terms do not reflect the percentage of FiO_2 delivered. What is meant here is the delivery of oxygen relative to peak inspiratory flow rates (Öztürk, 2015).

Nasal cannula, HOOD and Tent System, Simple Face Mask, Reservoir Mask and Diffuser Mask are among the low-flow oxygen therapy application methods (Öztürk, 2015). Among the high-flow oxygen systems are Venturi Mask, Continuous Positive Airway Pressure (CPAP) therapy, Bi-level Positive Airway Pressure (BiPAP) therapy, and High-Flow Nasal Cannula Oxygen Therapy (HFNC) (Conk, et al., 2011).

Oxygen therapy is one of the most important issues that physicians and nurses should master in terms of its frequency of use and effects. Oxygen therapy should be administered by a disciplined team only when clinically indicated, if possible, after side effects have been minimized. (Siela and Kidd, 2017, pp.58-70). Nurses play a vital role as a member of the healthcare team in the provision of appropriate oxygenation to the patients. It was stated that O_2 therapy is a fundamental part of nursing care and should be implemented successfully (Brokalaki et al., 2004, pp. 352–357). Oxygen therapy is a process consisting of the following steps: choosing the appropriate method according to the patient's age and needs, following-up the patient for therapeutic purposes, and termination of treatment (McGloin, 2008, pp.46-48).

Oxygen therapy is a complicated nursing procedure (Getahun, et al., 2022 pp.76). In Brokalaki et al.'s study (2004), while some of the physicians and nurses believed that oxygen was a medicine, the others believed that oxygen was a gas that improved the breathing of patients. In the same article the nurses' role concerning O_2 administration was found to be more important in an intensive care unit setting compared to surgical and medical departments. This may stated to be that intensive care unit nurses may be more experienced and familiar with its use and administration of oxygen. It has been recommended that nursing protocols should be implemented, and guidelines regarding O_2 control should be used to reduce adverse event and negligence during the use of oxygen (Brokalaki et al., 2004, pp. 352–357).

This study was aimed at identifying the roles and responsibilities of nurses in the administration of HFNC in pediatric services. In recent years, there has been an increase in the number of studies on the use of oxygen in our country, Turkey. Since nurses are responsible for implementing HFNC, observing the effectiveness of the treatment, monitoring children during HFNC, and maintaining their activities of daily living, evidence-based nursing approach is of importance for the implementation of HFNC.

High-Flow Nasal Cannula Oxygenation

High-flow nasal cannula oxygen therapy (HFNC) which meets the patient's ventilation need is a non-invasive ventilation system in which warmed and humidified oxygen is administered to the patient at varying flows with the help of a nasal cannula (Kawaguchi et al., 2017, pp. 112–119; Mikalsen et al., 2016, pp. 1-12). Today, for adults and children, various devices that can provide both FiO_2 and greater than 90% relative humidity by using warmed and umidified O_2 flows up to 40 L/min. are available (Kacmarek et al., 2019, pp. 838-878). HFNC systems are generally made up of the same components, although they differ from one manufacturer of the device to another manufacturer. As is seen in Figure 1, these components are a nasal cannula in the appropriate size for the patient, a sterile water tank, an oxygen-air mixer, a warmed and insulated circuit that provides air conduction, and an air humidifier (Lee et al., 2013, pp. 247–257; Slain et al., 2017, pp. 256–262).

Setting HFNC;

1) Humidifier chamber: Slide the humidifier chamber onto the humidifier.

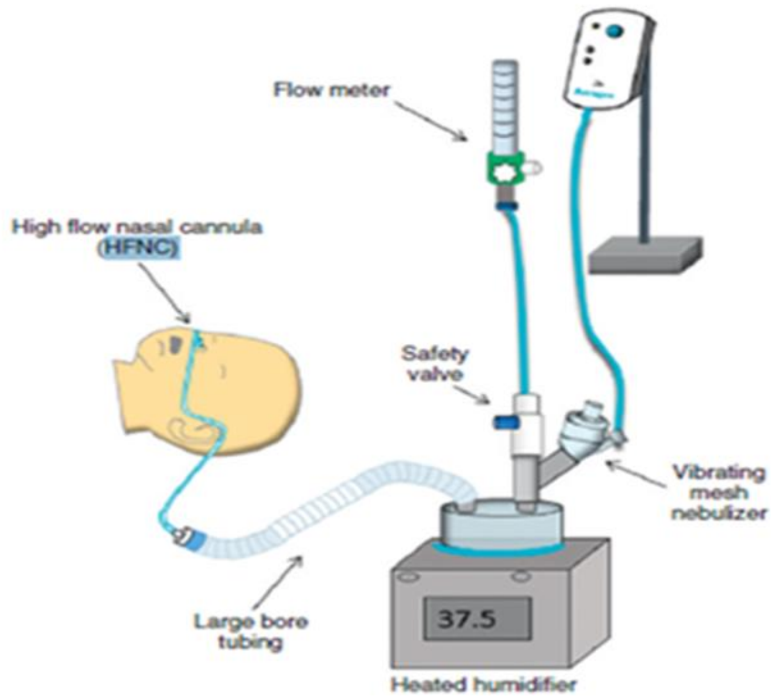
2) Distilled water: Connect the water bag to the moistened reservoir.

3) Oxygen: Connect the oxygen tube to the source.

4) Connect the circuit: Connect one end of the circuit to the device and the other end to the cannula.

5) Attaching the Nasal Cannula: Insert the nasal cannula into the patient's nostrils and snap into place with adhesive pads placed over the cheeks (Sachdev and Rauf, 2019, pp. 1-7).

Figure 1: High Flow Nasal Cannula



Reference: Kacmarek, R., Stoller, J., & Heuer, A. (2019). Robert M Kacmarek, James K Stoller, Al Heuer—Egan's Fundamentals of Respiratory Care-Mosby (2020).pdf (12.)

Traditionally, in neonates, flow rates exceeding 1-2 liters per minute (1 L/min) are considered as "high flow". However, recently, flow rates of up to 8 L/min are used in young children, and flow rates up to 60 L/min are used in children and adults (Groves and Tobin, 2007, pp. 126–131; Holleman-Duray et al., 2007, pp. 776–781). The main issue in managing these high flow rates is the need for the warming and humidifying of O_2 (Holleman-Duray et al., 2007, pp. 776–781). HFNC systems are increasingly used in infants, children and adults. Compared to normal nasal cannula and facemask oxygenation, HFNC provides a high level of respiratory support. HFNC was originally used as an alternative respiratory support to nasal Continuous Positive Airway Pressure (CPAP) therapy in premature infants; however, it is now increasingly used in patients with respiratory distress (Lee et al., 2013, pp. 247–257). Our review of the literature demonstrated that the first study on HFNC was conducted in 2001to compare HFNC with CPAP therapy in the management of Apnea of Prematurity (PM). At the end of the study, it was determined that HFNC was as effective as CPAP therapy in the management of Apnea of PM (Sreenan et al., 2001, pp. 1081–1083).

HFNC has a number of advantages and benefits over traditional oxygen delivery systems such as washing the nasopharyngeal dead space, warming and humidifying the air under appropriate conditions, reducing the inspiratory resistance and respiratory workload, improving the conduction and compliance in the airway, the PEEP effect and constant FiO_2 (Chidekel et al., 2012, pp.1-8; Dysart et al., 2009, pp. 1400–1405; Lee et al., 2013, pp. 247–

257; Onur et al., 2018, pp. 33–37). One of the advantages of HFNC is that it requires minimal technical skill for setup and administration (Kelly, Simon and Sturm, 2013).

Effect Mechanism

HFNC has a number of advantages and benefits over traditional oxygen delivery systems. HFNC increases air circulation with its heated and humidified system and ensures the excretion of CO_2 accumulated in the anatomical dead space (Dysart et al., 2009, pp. 1400–1405; Lee et al., 2013, pp. 247–257). Thanks to the HFNC application, humidified and heated air increases the physiological harmony of the lungs, facilitates the clearance of secretions and increases the comfort of the patient (Lee et al., 2013, pp. 247–257; Slain et al., 2017, pp. 256–262). The high flow air mixture given to the patient with a properly selected and correctly placed nasal cannula reaches the patient by bypassing the patient's greatest resistance point in inspiration, and reduces the respiratory workload (Büyükşen et al., 2021, pp.7-14). The HFNC system creates a CPAP effect by applying high flow, and keeps the small airways open, increases lung compliance, and improves ventilation. HFNC increases positive airway pressure in order for the patient to breathe slowly and deeply. As a result, alveolar ventilation increases (Nielsen et al., 2018, pp. 147-157). HFNC can provide the desired FiO_2 level with a flow rate that can be adjusted between 30-100 L/min (Chidekel et al., 2012, pp.1-8; Dysart et al., 2009, pp. 1400–1405; Lee et al., 2013, pp. 247–257; Onur et al., 2018, pp. 33–37).

In addition, the use of HFNC as a respiratory support method is increasing in infants and adults as an alternative to noninvasive positive pressure ventilation (Lee et al., 2013, pp. 247–257). The major known benefits of HFNC over other non-invasive respiratory support systems are that it is easy to administer and that compared to nasal Continuous Positive Airway Pressure (CPAP) therapy, the majority of patients can tolerate it without sedation (Hough et al., 2012, pp. 106–113).

Indications and Contraindications

Patients with moderate and severe bronchiolitis comprise the patient group with the highest level of evidence for HFNC. There is evidence supporting the effect of HFNC in the treatment of acute hypoxemic respiratory failure in the critical care setting (Ricard et al., 2020, pp.1-10) and the prevention of respiratory failure after extubation (Akyildiz et al., 2018, pp. 126-133; Byerly et al., 2005, pp.121-125), preoxygenation before intubation or during bronchoscopy (Huang et al., 2019, pp.10), and postoperative respiratory failure (Kawaguchi et al., 2017, pp. 112–119).

Although limited, there are data on the use of HFNC in patients with hypercapnic respiratory failure in addition to pulmonary rehabilitation and in the palliative care setting (D’Cruz et al., 2020, pp.4; Lodeserto et al., 2018). HFNC is considered less invasive than CPAP therapy. It is better tolerated by patients and easier to administer by doctor and nurses (Yoder et al., 2013, p.1482–1490). In a study conducted with premature babies who received

CPAP therapy, the rate of the nasal trauma observed after extubation was higher in them than was that in the group that received HFNC, and the rate of sedation use in HFNC was lower compared to that in CPAP therapy (Ten Brink et al., 2013, pp. 326–331). In preterm infants, HFNC can be used to prevent reintubation and to provide noninvasive. There have also been some studies examining whether HFNC is effective in children with asthma and whether it reduces the need for intubation (Baudin et al., 2017, pp.1-9; Kelly et al., 2013, pp. 888–892; Wing et al., 2012, pp. 1117–1123).

In their study (2012), Wing et al. demonstrated that the use of HFNC is associated with a decrease in the need for intubation and a decrease in mechanical ventilator utilization in children who present to the emergency department and are subsequently admitted to the PICU with acute respiratory insufficiency. Following the implementation of the guideline, HFNC use increased dramatically, and intubation rates concomitantly decreased (Wing et al., 2012, pp. 1117–1123).

It was determined that warmed and humidified oxygen would be even more beneficial in preventing airway inflammation and bronchospasm. In children, adjustment of the flow level is essential to achieve the maximum efficacy and to prevent complications. If issues related to the adjustment of the flow level, indications and contraindications, device management, efficacy identification and safety are to be eliminated, particularly in children, clinical guidelines on how to administer HFNC should be developed (Kwon, 2020, pp.1370–1373). HFNC has some side effects such as air leakage, pneumothorax, abdominal distention, dry mouth, aspiration risk, nasal traumas, epistaxis, and in such cases, HFNC should not be implemented. The HFNC should not be implemented if there are facial, nasal, or airway anomalies that may prevent nasal cannula application (Al-Subu et al., 2017, pp. 945–953; Kallappa et., 2014, pp. 790–791; Ten Brink et al., 2013, pp. 326–331). Table 1 shows the indications, contraindications and advantages of HFNC.

Table 1. Indications – Contraindications - Advantages of HFNC

Indications	Contraindications	Advantages
• Moderate to severe bronchiolitis • Treatment of acute hypoxemic respiratory failure • Prevention of respiratory failure after extubation • Preoxygenation before intubation or during bronchoscopy • Hypercapnic respiratory failure	• Air leak • Pneumothorax • Abdominal distention • Dry mouth • Aspiration risk • Epistaxis • Those with face, nose and airway anomalies • Nasal traumas	• Less nasal trauma • Less need for sedation • Minimum technical skill for installation and implementation • The infant's movement is not interfered • Reduced need for intubation • Prevention of bronchospasm • Ease of nursing care • Providing baby's comfort

HFNC Pediatric Guidelines

Although most studies conducted on HFNC have focused on its use in intensive care units, recent studies have shown that HFNC can be used to manage moderate respiratory distress in emergency department. Although the number of studies conducted on the implementation HFNC has increased, there is no clear consensus on the ideal flow rate in the literature (Büyükşen et al., 2021, pp.7-14; Kwon, 2020, pp.1370–1373; Mikalsen et al., 2016, pp.1-12). Thanks to its indications and benefits, administration of HFNC is likely to increase in the future. Therefore, further studies should be carried out to ensure the development of evidence-based guidelines on its use (Milési et al., 2014, pp. 1–7).

Flow Rates in HFNC for Infant

High flow oxygen is administered in neonatal intensive care units (NICUs). For neonates, any flow rate greater than 1 L/min is generally considered high flow. Given this definition, the use of high-flow oxygen in neonates has increased (Lee et.al., 2013, pp. 247–257).

An issue leading to confusion in the evaluation of the efficacy of HFNC in neonates is that various definitions are used. While in some studies, the flow rate >1 lpm has been considered as standard for the high-flow nasal cannula therapy in neonates (Büyükşen et al., 2021, pp.7-14; Eklund and Scott, 2018, pp. 400-412; Ignatiuk et al., 2020, pp. 2791–2798; Mikalsen et al., 2016, pp.1-12; Sögütlü et al., 2016, pp. 121-130), in some studies, the flow rate> 2 lpm has been defined as standard (Al-Mukhaini and Al-Rahbi, 2018, pp. 278-285; Kugelman, 2020; Milési et al., 2014, 2017, 2018, pp. 1–7, pp. 209–216, pp. 1870–1878)

Flow Rates in HFNC for Children

Data on the use of HFNC in infants and children are even more limited than in neonates. In children, the range of flows considered high flow varies depending on the age and weight of the child, and flow rates > 6 L/min are generally considered high flows (Lee et al., 2013, pp. 247–257; Milési et al., 2014, pp.1-7).

In a study, it was determined that a flow rate of 3 L/kg/min was not superior to 2 L/kg/min when HFNC was used for the primary treatment of moderate to severe bronchiolitis in infants younger than 24 months. Therefore, it was concluded that 2 L/kg/min should be preferred in clinical practices since it was better tolerated by patients (Milési et al., 2018, pp. 1870–1878). Lack of studies in which higher flow rates are used, and case reports of severe air leak in children treated with HFNC (Hegde and Prodhan, 2013, pp. 939–944), suggest that outside the PICU, flow rates greater than 1 L/kg/min in children or greater than 10 L/min in infants should be cautiously used (Mikalsen et al., 2016, pp.1-12). In a study involving children hospitalized in a general pediatric ward due to bronchiolitis, a maximum flow of 10 L/min and a flow of 2 L/kg/min were safely used with no adverse effects (Mayfiel et al., 2014, pp. 373–378).

Weaning of HFNC

There is not sufficient evidence suggesting that no approach is more effective than any other approach in the termination of HFNC. In their review (2015), Hutchings et al. proposed a guideline including strategies on the initiation, escalation, and discontinuation of HFNC in a general pediatric ward. In this local guideline, baseline flow was determined by age, and if scores in the patient scoring system were above a certain level, the flow rate was increased. They stated that if a certain respiratory component fell below its initial level, HFNC should be discontinued (Hutchings et al., 2015, pp. 571-575).

Nurses' Roles and Responsibilities in the Implementation of HFNC

The nurse plays a great role in recording the use, management, follow-up and effectiveness of HFNC. Through the HFNC application, the patient's need for nursing care is reduced. In a study, nurses were determined to have perceptions that not much nursing expertise and education are required to administer HFNC safely. In the same study, CPAP therapy was compared and HFNC was concluded that the former had advantages over the latter one such as "it is easier for the personnel to manage it", "it does not require constant attention", "provision of nursing care is easy", "it does not prevent the baby from moving", and "it provides comfort. (Manley et al., 2012, pp.16-21).

There are differences between nurses' and physicians' practices during HFNC practice. In Eklund et al.'s study (2018), of the nurses who participated in their study, 60.1% answered that the flow rate was determined as 1 L/min in order to switch from HFNC to nasal cannula treatment, while 9.7% replied that they switched directly to the room air. It was determined that nurses implemented HFNC more frequently than did neonatologists. Therefore, in order to set standards for the initial flow rates, strategies for the termination of HFNC and clinical practice, and minimize variations in clinical practices more studies should be conducted (Eklund and Scott, 2018, pp. 400-412).

Nurses' opinions about the use and advantage of HFNC in the newborn after extubation differ. In Roberts et al.'s study conducted on the use of HFNC as a post-extubation support mode for extremely preterm infants (2014) most of the nurses preferred CPAP therapy for post-extubation support in the 24- or 26-week-old infants, but in the 28- and 30-week-old infants, the preferred HFNC to prevent intubation. Why they preferred HFNC to CPAP therapy was that HFNC had some advantages such as causing less nasal trauma, and providing better parental satisfaction, contact, interaction and infant care (Roberts et al., 2014, pp.806-810). In Hough et al.'s study (2012), the main perceived benefits of HFNC over CPAP were that HFNC was administered more easily, and it facilitated the provision of care to the infant, increased the infant's tolerance, reduced nasal trauma, increased nursing satisfaction, and improved mother-infant attachment and patient satisfaction (Hough et al., 2012, pp. 106–113). In Engesland et al.'s study (2016), the participating nurses stated that infants undergoing HFNC had a wider field of view, which made it easier for the infants to focus on the faces around them. Some nurses stated that infants were able to turn their heads easily if they wanted, so they were able to change their position and they were placed in a more comfortable position, and that infants were given a pacifier to comfort them, which was difficult during CPAP therapy. Nurses are increasingly faced with the dilemma whether to provide the best treatment for the infant's respiratory condition or to give the infant the best nursing care. In Engesland et al.'s study the nurses stated that they were caught in a dilemma between providing 'care' which was their role, and providing 'treatment' which was traditionally the role of the physician. Therefore, when a nurse is to care for a infant who is resistant to CPAP therapy but not ready to switch to HFNC, he or she will try to use soothing methods such as pacifiers, swaddling, sucrose or kangaroo care. When the infant is ready to switch to HFNC, the nurse should focus on the 'treatment' more and be aware of all changes in the infant's respiratory status, monitor the infant carefully and detect any changes in the infant and react as quickly as possible. The nurse should constantly switch between the two options, make observations and evaluations about which option should be chosen, and discuss it (Engesland and Johannessen, 2016, pp. 21–26).

In their retrospective (2021) in which the nurse's perspective on the patient's nutritional status during HFNC application was investigate, Conway et al. compared the safety of oral feeding before and after the application of the feeding guideline during HFNC administration in infants with bronchiolitis, they determined that the HFNC flow rate (L/min) before the application of the feeding guideline was higher than was that after the application of the feeding guideline. They also determined that the length of stay in the pediatric intensive care unit decreased in those to whom the guideline was applied. Using existing guidelines reduced the time spent in NPO (Nil'Per Os) by ensuring earlier feeding of children during follow-up with HFNC (Conway et al., 2021).

In their study conducted on the ratio of the number of patients treated with HFNC to caregiver nurses Novak et al. stated (2021), that the number of nurses required for the care of the patients followed up with HFNC and personnel for the patients in the clinics was insufficient, that while the patient-nurse ratio was 1:1 in one center, it was 3:1 in another center. “There is no consensus on patient-nurse ratios or frequency of patient evaluations at the physician level, and most clinics have reported different ratios” (Novak et al., 2021, pp. 414-420).

In Table 2, the comparison of HFNC protocols in the literature is given. Since there is no clear consensus on HFNC application in the literature, the protocols included in different studies are shown in Table 2. These protocols were created by scanning studies in the literature. Articles indicating the HFNC application in pediatric patients in the form of algorithms are given in this table.

Table 2: HFNC Initiation and Weaning Guidelines

Article	Country	Weight	Age (month)	Flow rate	FiO2/ Saturation	Nasal Cannula	Considerations	HFNC Weaning Guidelines
Milési et. al, 2014	France		Infants	>2L/min i.e., 2 L/kg/min)	FiO2: to reach pulse oximetry (SpO2) 92-97%	Nasal cannula size: ½ nostril diameter	Consciousness, Airway patency Respiratory rate (RR), chest rising, FiO2 and SpO2, Heart rate (HR), blood pressure, Comfort	*Improvement in most parameters:* particularly RR, FiO2, HR, comfort **After 12 hours:** Possible transfer to a pediatric ward depending on the hospital policy *Worsening of some parameters:* particularly RR, FiO_2, HR, comfort Keep or transfer to PICU Change to NIV or invasive ventilation
			Children	>6 L/min (i.e., 1 L/kg/min				
Riese, Fierce, Riese and Alverson, 2015	USA		<6 month	2L/dk-8L/min	>%92		Inititation of HFNC may ocur on the wards, and patienst may remain on the wards as long as clinical stability is established. Higher flow rates may be needed on the basis of clinical judgment and patient disease process. Once initial flow rate is established, wean FiO_2 to lowest % tolerated to maintain target O_2 sat.	**<18 month** Patient receiving 2L/min via HFNC and requires FiO_2 $\leq$ 40%, can transition to standard nasal cannula $\leq$ 1L/min to maintain O2 sat $\geq$ 92% **$\geq$ 18 month** Patient receiving 4L via HFNC and requires FiO_2 $\leq$ 40%, can transition to standard nasal cannula <= 2L maintain O_2 sat $\geq$ 92%
			6-18 month	4L/dk-12L/min				
			>18 month	8L/dk-15L/min				
Franklin et. al, 2015	Australia New Zeland		< 12 month	2L/min/kg Max;25L/min	-	-		Responders in the standard subnasal oxygen therapy arm will be weaned from 2 L/min or less if SpO2 remains stable at 92-98 % (94-98 %). For responders in the HFNC therapy arm, flow rates will be kept at 2L/kg/min, while FiO_2 is decreased. Flow rates are not to be weaned and are to be maintained at 2L/kg/min until

								HFNC therapy is ceased and turned off completely.. Once FiO2 has reached 21 % with SpO2 maintained between 92-98 % (94-98 %) for four hours the high flow off is turned off and the nasal cannula are removed.
Ramnarayan et. al, 2017	England	<10 kg		2L/kg/min		-	Measure and record vital signs and clinical observations at least every hour for the first 6 hours	*At treating clinician's discretion when* **$FiO_2 < 0.40$;** • 50% of original flow rate, • At treating clinician's discretion; • Switch to low flow nasal cannula oxygen Persistent or worsening respiratory failure Evidence by one one or more **$FiO_2 > 0.60$;** • Recurrent apnoeas pH ≤ 7.20; pCO2 > 7.5 kPa • Respiratory distress worsens; • (Crossover to CPAP or BİPAPor Endotracheal intubation)
		10-20 kg		25L/min				
		20-30 kg		30L/min				
		30-40 kg		35L/min				
		40-50 kg		40L/min				
		50-60 kg		45 L/min				
		>= 60 kg		50L/ min				
Richards-Belle et. al, 2020	England	<=12 kg		2L/kg/min	<=0.40	-	**One or more of:** • Fi02 < 0.30 • Mild/no respiratory distress **OFF HFNC for ≥48 hours**	2L/min/kg--------1L/min/kg
		13-15 kg		25-30L/min				25-30L/min-------13-15 L/min
		16-30 kg		35L/min				35L/min-----------18L/min
		31-50 kg		40L/min				40L/min------------20 L/min
		>50 kg		50L/min				50L/min------------25L/min

							• Trial treatment complete **Indicated by one or more of:** • Severe respiratory distress • Fi02 $\geq$ 0.60 • Patient discomfort • To other forms of non-invasive AND/OR Invasive Ventilation	
Peterson et. al, 2021	USA				-		**Soft Escalation Notify PICU Resident**	**Hard Escalation Notify PICU Attending/Fellow**
			<=1month	6L/min		Yellow cannula	None	Increase flow by 2L Q 15-30 minutes to a maximum of 8L
			1-12 month	8L/min		Purple cannula	Increase flow by 2L Q 15-30 minutes to 14L	Above 14L, increase flow by 2L Q 15-30 minutes to a maximum of 20L
			1-5 years	10L/min		Green cannula	Increase flow by 2L Q 15-30 minutes to 20L	Above 20L, increase flow by 2L Q 15-30 minutes to a maximum of 25L
			6-12 years	12L/min		Green cannula	Increase flow by 2L Q 15-30 minutes to 20L	Above 20L, increase flow by 2L Q 15-30 minutes to a maximum of 25L
			>= 13 years	15L/min		Clear cannula	Increase flow by 5L Q 15-30 minutes to 40L	Above 40L, increase flow by 5L Q 15-30 minutes to a maximum of 60L

2. CONCLUSION

In our country, Turkey, there is a gap in the literature related to studies conducted on HFNC. The lack of such studies suggests that there may be a lack of information about the device and treatment method. Creating a nursing protocol that nurses can use during the follow-up of the child in the clinics will be beneficial in terms of creating a common language regarding the use of HFNC. Our review of the literature revealed that there were various hospital protocols regarding the use of HFNC. The fact that nurses are the decision makers in initiating, maintaining and terminating HFNC in some countries is another reason that nursing studies should be conducted in this regard in our country.

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