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The High-flow Nasal Cannula Practices of Pediatric Intensive Care and Pediatric Emergency Specialists in Turkey

Türkiye'deki Çocuk Yoğun Bakım ve Çocuk Acil Uzmanlarının Yüksek Akışlı Nazal Kanülle Oksijen Tedavisi Uygulamaları

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Abstract

Introduction: To date, no consensus has been reached on the start, monitoring and termination methods for high-flow nasal cannula oxygen (HFNC) treatment in children. Therefore the aim of this study was to evaluate the HFNC practices of pediatric emergency and pediatric intensive care specialists in Turkey.

Methods: A total of 85 pediatric emergency and pediatric intensive care specialists from 22 cities participated in this questionnaire study. The questionnaire consisted of 20 items related to HFNC indications, complications, preferred settings, follow-up and weaning methods.

Results: To start HFNC, 22.4% of the respondents reported using a scoring system. It was reported with FiO_2 >50% by 57.6% and <50% by 42.4% of the respondents. The decision to terminate HFNC was stated to be based on a scoring system by 31.7%. It was stated by 91.8% of respondents that HFNC treatment was terminated by reducing the flow, and 8.2% directly terminated the treatment. The most common indication for HFNC was acute bronchiolitis in both the emergency department and pediatric intensive care.

Conclusion: It was determined that the majority of pediatric emergency and pediatric intensive care specialists based their decisions for starting, monitoring and terminating HFNC on the examination findings of the patient and did not use any scoring system or protocol.

Keywords: Respiratory failure, high flow nasal cannula, pediatric intensive care, pediatric emergency

Öz

Giriş: Çocuk hastalarda yüksek akışlı nazal kanül oksijen (YANKO) tedavisinin başlama, izleme ve sonlandırma yöntemleri konusunda fikir birliği bulunmamaktadır. Bu çalışmada, Türkiye'deki çocuk acil ve çocuk yoğun bakım uzmanlarının YANKO uygulamaları araştırılmıştır.

Yöntemler: Bu anket çalışmasına 22 şehirden toplam 85 çocuk acil ve çocuk yoğun bakım hekimi katıldı. Yirmi sorudan oluşan ankette, YANKO endikasyonları, komplikasyonları, tercih edilen ayarlar, takip ve ayırma yöntemleri araştırıldı.

Bulgular: YANKO tedavisi başlamak için, katılımcıların %22,4'ü bir puanlama sistemi kullandığını bildirdi. Katılımcıların %57,6'sı %50'nin üzerinde ve %42,4'ü %50'nin altında bir FiO_2 ile tedaviye başlamaktaydı. YANKO'yu sonlandırma kararı %31,7 oranında puanlama sistemine dayalıydı. Ankete katılanların %91,8'i YANKO tedavisini akışı azaltarak sonlandırırken %8,2'si doğrudan tedaviyi sonlandırmaktaydı. YANKO için en yaygın endikasyon hem çocuk acil hem de çocuk yoğun bakımda akut bronşiolitti.

Sonuç: Çocuk acil ve çocuk yoğun bakım hekimlerinin büyük çoğunluğunun YANKO başlatma, izleme ve sonlandırma kararlarını hastanın muayene bulgularına göre verdiklerini ve herhangi bir skorlama sistemi veya protokolü kullanmadıkları belirlendi.

Anahtar Kelimeler: Solunum yetmezliği, yüksek akışlı nazal kanül, çocuk yoğun bakım, çocuk acil

Introduction

High-flow nasal cannula (HFNC) oxygen treatment is a non-invasive method that provides acute respiratory support to improve ventilation and oxygenation in respiratory tract diseases in children. This method facilitates mucociliary transport, reduces airway secretions and viscosity, prevents the collapse of the upper airway, and increases residual functional capacity.

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In the literature, there are studies reporting that it is effective and safe in the indications of acute bronchiolitis, asthma, pneumonia, sleep apnea syndrome, patient transport, post-extubation respiratory support in children.[1-4] The greatest concern during the use of HFNC is the delay in switching to advanced respiratory support methods in the event of HFNC failure. Therefore, studies focused on determining the parameters that can be used to predict HFNC failure in children.[5-8]

Despite the increasing use, no consensus has yet been reached on the indications and initial settings, duration and weaning method for HFNC in pediatric patients. The aim of this study was to determine the indications of pediatric emergency and pediatric intensive care unit (PICU) specialists in Turkey for starting HFNC and the methods of initiation, maintenance and weaning, and to determine the frequency of scoring use in these stages.

Materials and Methods

A 20-item questionnaire was prepared to be delivered over the internet to physicians working as specialists, medical residents and faculty members in pediatric emergency and PICUs. Open-ended, single and multiple answer questions were asked. The questionnaire form can be seen in Table 1. The participants were asked about initiation, maintenance, and weaning methods for HFNC treatment, whether scoring is used, device brands, indications and complications. Approval for the study was granted by the Clinical Research Ethics Committee of Ondokuz Mayıs University (date: 27.02.2020, no: 2020/92).

Statistical Analysis

Data obtained in the study were analyzed statistically using SPSS vn. 20.0 for Windows software. Descriptive statistics were stated as number (n) and percentage (%) for categorical variables, and as mean ± standard deviation, or median for continuous variables. The data of all the centres were collected and analysed in total. A value of $p<0.05$ was accepted as the level of statistical alpha signficance.

Results

A total of 85 specialists from 22 Turkish cities participated in the study, including 51 from pediatric emergency units and PICUs. The geographical distribution of the participants is shown in Figure 1. There were 21 PICU faculty members, 23 PICU specialists, 17 PICU medical residents, 7 pediatric emergency faculty members, 8 pediatric emergency specialists and 9 pediatric emergency medical residents (Table 2).

The HFNC devices used in the centres in the study were AIRVO (41 centres, 80.4%), OMNIOX (6 centres, 11.8%) and VAPOTHERM (5 centres, 9.8%). In 6 centres (11.8%), HFNC was applied using a hospital type mechanical ventilator (HAMILTON C3 and BELLA VISTA-100). The pediatric emergency units participating in the study had a mean of 17.1±6.7 beds and 4.3±3.1 HFNC devices. The PICUs had mean 13.8±9.7 beds

Table 1. Survey questions asked in the study

What is the province of work?	
Please specify your employed health institution.	
Please specify your title.	
Please specify number of beds in the unit.	
Please specify number of devices in the unit.	
Please specify brand of HFNC device used.	
Please select the approximate number of patients you have given HFNC treatment in one year?	• <25 • 25-50 • 50-75 • 75-100 • 100-125 • 125<
Where is your HFNC treatment starting place? (more than one answer can be selected)	• Pediatric emergency room • Pediatric intensive care • General ward
What is your frequency of using HFNC according to diagnoses? (more than one answer can be given)	
What is your initial FiO_2 setting?	• <50% • >50%
Do you use scoring to initiate HFNC therapy?	(Yes/no)
Do you use scoring to evaluate HFNC treatment efficacy?	(Yes/no)
What conditions do you consider as treatment failure? (more than one answer can be given)	
What is your frequency of evaluation of HFNC treatment efficacy?	• Hourly • First hourly, then every 2 hours • Every 2 hours • Every 4 hours
Is there a standard protocol you use for weaning?	(Yes/no)
What is your weaning method?	• By reducing the flow • Directly
Which oxygen support method you choose after HFNC treatment? (more than one answer can be selected)	• Mask with reservoir • Nasal cannula • Hood • Room air (21%)
What are the complications you encounter with the use of HFNC? (more than one answer can be given)	
Do you routinely use sedation?	(Yes/no)
If yes, what is your preferred sedative drug?	

HFNC: High-flow nasal cannula oxygen

and 4.7±4.03 HFNC devices. The ratio of HFNC devices to beds was calculated as 0.25 in pediatric emergency units and 0.34 in PICUs. The frequency of applying HFNC in a year in the unit was reported to be >125 times by 25.5%, 100-125 times by 7.8%, 75-99 times by 19.6%, 50-74 times by 27.5%, 25-49 times by 11.8%, and <25 times by 7.8%.

Figure 1. The geographical distribution of the participants

For the initiation of HFNC treatment, 77.6% stated that they did not use any clinical scoring system and 22.4% said that there was a scoring system in their unit. Treatment was started with FiO_2 ≥50% by 57.6% of the respondents and <50% by 42.4%. In the evaluation of treatment efficacy, 54 (63.5%) stated that patients were evaluated hourly then every 2 hours, and 21 (24.7%) made evaluations with hourly monitoring. The decision to terminate HFNC treatment was made using a scoring system by 31.7%. While 91.8% applied weaning by reducing the flow, HFNC treatment was directly terminated by 8.2%. After the termination of HFNC, oxygen treatment was preferred with reservoir oxygen mask by 65.8%, nasal cannula by 47.1%, room air by 22.4%, and hood by 11.8% (Table 2).

The indications for HFNC use indicated by pediatric emergency specialists were bronchiolitis, pneumonia, asthma,

Table 2. High flow nasal cannula methods of pediatric emergency and intensive care specialists

	Pediatric emergency	Pediatric intensive care	Total (%)
Number of centers	15	36	51
Number of physicians	24	61	85
Faculty members	7	21	28
Specialists	8	23	31
Minor branch asistants	9	17	26
Number of devices	4.3±3.1	4.7±4.04	4.61±3.76
Number of beds	17.1±6.7	13.8±9.7	14.8±9.05
Device/bed ratio	0.25	0.34	0.31
HFNC patients per year			
25>	1	3	4 (7.8%)
25-49	4	2	6 (11.8%)
50-74	3	11	14 (27.5%)
75-99	2	8	10 (19.6%)
100-125	1	3	4 (7.8%)
125<	4	9	13 (25.5%)
HFNC initial scoring			
Yes	8 (33.4%)	11 (18.1%)	19/85 (22.4%)
No	16 (66.6%)	50 (81.9%)	66/85 (77.6%)
HFNC termination scoring			
Yes	11 (45.9%)	16 (26.3%)	27/85 (31.7%)
No	13 (54.1%)	45 (73.7%)	58/85 (68.3%)
Initial FiO_2			
<50%	9 (37.5%)	27 (44.3%)	36 (42.4%)
≥50%	15 (62.5%)	34 (55.7%)	49 (57.6%)
Frequency of evaluation			
Hourly	6 (25%)	15 (24.6%)	21 (24.7%)
First hourly, then every 2 hours	12 (50%)	42 (68.9%)	54 (63.5%)
Every 2 hours	2 (8.3%)	1 (1.6%)	3 (3.5%)
Every 4 hours	4 (16.7%)	3 (4.9%)	7 (8.2%)
Weaning method			
By reducing the flow	22 (91.7%)	56 (91.8%)	78 (91.8%)
Directly	2 (8.3%)	5 (8.2%)	7 (8.2%)
Oxygen after weaning			
Mask with reservoir	18 (75%)	38 (62.3%)	56/85 (65.8%)
Nasal cannula	5 (20.8%)	35 (57.4%)	40/85 (47.1%)
Hood	2 (8.3%)	8 (13.1%)	10/85 (11.8%)
Room air (21%)	6 (25%)	13 (21.3%)	19/85 (22.4%)

HFNC: High-flow nasal cannula oxygen

chronic lung diseases, bronchopulmonary dysplasia, lung edema, acute respiratory distress syndrome, respectively. For PICU specialists, these indications were post-extubation, bronchiolitis, pneumonia, chronic lung diseases, asthma, bronchopulmonary dysplasia, and upper airway stenosis, respectively. The conditions accepted as failure in HFNC treatment are shown in Table 3. None of the participants reported that routine sedation was initiated at the start of HFNC treatment.

When asked about the frequency of HFNC complications, they were listed as patient incompability, nasal obstruction, cannula obstruction, abdominal distention, dermatitis according to pediatric emergency specialists, and nasal obstruction, cannula obstruction, patient incompability, dermatitis, abdominal distention according to intensive care specialists.

Discussion

The results of this questionnaire study showed that the majority of respondents did not use a scoring system for starting and monitoring HFNC treatment, and the rate of use of a scoring system was determined as 22.4%. In the decision to terminate treatment 31.7% of the study participants stated that they used a scoring system. It was determined that those who did not use a scoring system based their decisions for starting, maintaining, monitoring and terminating HFNC treatment on the examination findings of the patient. In a recent international study of the HFNC practices of PICU specialists, it was reported that HFNC treatment efficacy was usually evaluated by examining respiratory count and respiratory workload, and only 16% used a respiratory scoring system.[9]

Close monitoring of response to treatment in patients who have started HFNC and early identification of treatment failure and intervention are important in respect of patient prognosis. In the current study, 63.5% of the respondents stated that they evaluated patients hourly at first then once every 2 hours in the first 24 hours of HFNC treatment, 24.7% stated that they made hourly evaluations, 3.5% stated 2-hour intervals and 8.2%, 4-hour intervals. The most commonly accepted finding of treatment failure was hypoxemia. In countries with limited resources, such as Turkey with the total number of HFNC devices per bed as 0.31, it can be considered more appropriate to use a respiratory scoring system for initiation, monitoring and termination, to prevent unnecessary lengthy use of the devices. The use of a scoring system during follow-up could also contribute to the early identification of treatment failure.

Table 3. Conditions or symptoms indicating HFNC treatment failure

	Pediatric emergency	Pediatric intensive care
1	Hypoxemia	Hypoxemia
2	Increase of retractions	Worsening of mental status
3	High FiO_2 requirement	Increase of retractions
4	Hypercapnia	Hypercapnia
5	Worsening of mental status	Circulatory disorder
6	Circulatory disorder	High FiO_2 requirement
7	Tachycardia	Tachycardia
8	Patient incompability	Patient incompability
9	Mucus hypersecretion	Mucus hypersecretion

HFNC: High-flow nasal cannula oxygen

The most common diagnosis for which HFNC is applied in the pediatric age group is acute bronchiolitis. In a randomized, controlled study of pediatric acute bronchiolitis patients requiring oxygen treatment, HFNC treatment was seen to significantly reduce treatment failure compared to standard oxygen therapy.[10] Other indications in children that have been reported in literature include asthma, sleep apnea, pneumonia, critical patient transport and the need for respiratory support after extubation.[2] In the current study, the most common indication for HFNC was reported to be acute bronchiolitis by both the emergency and PICU specialists.

In HFNC treatment, it is necessary to set the two parameters of flow speed and FiO_2. There is no protocol related to the most appropriate initial settings for children. In a study that compared the efficacy of HFNC and continuous positive airway pressure, there were reported to be great differences between centres in respect of the highest flows given to pediatric patients.[11] Besnier et al.[12] reported that initial settings varied in adults with 58% of participants reporting that they started with 100% FiO_2 and gradually reduced the flow, and 28% reported starting at >50 L/min. In the current study, the initial FiO_2 value was stated to be >50% by 57.6% of the respondents and <50% by 42.4% of the respondents. There can be considered to be a clear need for further studies related to the optimum initial flow and FiO_2 settings for pediatric patients.

The respective frequency of complications was seen to be similar according to the pediatric emergency and PICU specialists. Patient incompatibility was the most common complication reported by the pediatric emergency specialists and the 3rd most common complication after nasal or cannula obstruction by the PICU specialists. Patient tolerance is higher in PICUs, which may be associated with sedation and analgesia agents started for other reasons. There are also fewer external factors that may cause agitation in children in pediatric emergency units. None of the study participants stated routinely starting sedation and analgesia during HFNC treatment but stated that they would start it if necessary. No data could be found in literature related to the administration

of analgesia and sedation during HFNC treatment or which agents are preferable if applied. The current study participants stated a preference for 55% (n=47) ketamine 31% (n=26) dexmedetomidine and 14% (n=12) midazolam for sedation and analgesia.

There is no consensus on the procedure for weaning pediatric patients off HFNC treatment. Betters et al.[13] defined the "HFNC holiday" protocol for this purpose and reported that 89% of patients with a score of <6 in 12 hours when evaluated with a "respiratory assessment score", formed according to the patient respiratory findings, could be successfully weaned in mean 18 hours.

In a questionnaire study related to practices for adult patients, 81% of respondents reported that it was necessary to reduce FiO_2 first, 6% said to reduce flow first and 13% said to reduce both at the same time.[14] In a study by Franklin et al.[10] patients were monitored for 4 hours at FiO_2 20% and if saturations could be held at the target of 92-94%, treatment was terminated. In the current study, 31.7% of the respondents used a protocol to terminate HFNC treatment, 91.8% by reducing flow and 8.2% by direct termination. There is a need for standardization of the weaning method by reducing flow, and this would have a positive effect on the duration of HFNC and the length of stay in intensive care and hospital. As weaning may be unsuccessful due to the underlying disease of the patient or the reason for starting HFNC, there is a need for further studies to establish how weaning should be achieved in which patients.

Study Limitations

Our study has some limitations. The number of participants in the study is low, and our results may not reflect the practices of all pediatric emergency and intensive care specialists in our country. In addition, since the practices of the participants working in centers with HFNC application protocols will be similar, the selection of participants without such a distinction is another limitation.

Conclusion

The results of this study showed that the majority of pediatric emergency and PICU specialists did not use a scoring system and based their decisions for starting, monitoring, and terminating HFNC treatment on the examination findings of the patient. There is a need for further studies to standardise HFNC practices in terms of using limited devices for appropriate patients and for the required time, the early determination of failure, and for there to be comparable results of studies.

Information: This study was presented as a verbal report at the Pediatric Emergency and Intensive Care Symposium on February 27, 2021.

Ethics

Ethics Committee Approval: Approval for the study was granted by the Clinical Research Ethics Committee of Ondokuz Mayıs University (date: 27.02.2020, no: 2020/92).

Informed Consent: Informed consent was obtained.

Peer-review: Internally and externally peer-reviewed.

Authorship Contributions

Concept: M.Ü., Design: M.Ü., N.Y., Data Collection or Processing: M.Ü., H.A., Analysis or Interpretation: M.Ü., N.Y., Literature Search: M.Ü., H.A., Writing: M.Ü., N.Y.

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