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Review Article

HIGH-FLOW NASAL CANNULA OXYGEN THERAPY IN ASTHMATIC PATIENTS: A LITERATURE REVIEW

Shradha Shilpakar[1*], Geng Wan Ru[2], Ding Hai Dong[3] and You Shu Hong[3]

[1]School of Clinical Medicine, Inner Mongolia University for Nationalities, 538 West Huolin He Street, Horqin District, Tongliao city, Inner Mongolia, P.R.China.

[2]Department of infectious disease, Affiliated Hospital of Inner Mongolia University for Nationalities,1742 Huolin He Street, Horqin District, Tongliao city, Inner Mongolia, P.R.China

[3]Department of Respiratory Medicine, Affiliated Hospital of Inner Mongolia University for Nationalities,1742 Huolin He Street, Horqin District, Tongliao city, Inner Mongolia, P.R.China.

ABSTRACT

Introduction: Bronchial asthma is a chronic airway inflammatory respiratory disease, with cough, paroxysmal wheezing, and chest tightness as the main manifestations. High flow nasal oxygen inhalation is a new oxygen therapy method developed in recent years and has been established and widely studied in neonatal and pediatric settings. High flow nasal cannula (HFNC) oxygen therapy mixes a certain concentration of oxygen with high flow gas, and directly gives it to patients through an unsealed nasal cannula.

Method: PubMed, Geen Medical, Google scholar and Science direct were searched for all relevant previously published articles or abstracts in English. Terms like "Acute asthma exacerbation," "high flow nasal cannula oxygen," "asthmatic crisis," "HFNC in adults," "HFNC in asthma", "high flow oxygenation" were used for searching the related articles.

Results: Overall results of all the related studies revealed, in the first 2-3 hours of treatment of HFNC compared to COT heart rate, respiratory rate and pulmonary score decreased, over the time both subgroups HR, RR and PS reached normal range. In the case of FEV_1 after 24hours of treatment, both subgroups were improved significantly. A sum of 3 patients complained of intolerance to HFNC and two patients suffered from pneumothorax after use of HFNC. No deaths were recorded in these studies.

Conclusion: As compared to COT/NIV, HFNC used in asthmatic patients seems more comfortable and well tolerated by patients and as well heart rate, respiratory rate and pulmonary score decreased over the time. So, the HFNC oxygen therapy in asthma is being innovative and widely accepted oxygen therapy at present time.

Keywords: High flow nasal cannula (HFNC), oxygen therapy, conventional oxygen therapy, noninvasive ventilation, asthma

INTRODUCTION

Bronchial asthma is a chronic airway inflammatory respiratory disease, with cough, paroxysmal wheezing, and chest tightness as the main manifestations. In the world, about 300 million people suffer from asthma [1]. In China, a recent nationwide survey showed that the overall incidence rate was 4.2%, that is, 457000000 adults with asthma were diagnosed as [2] in adults. Among them, severe bronchial asthma is characterized by persistent dyspnea and airway obstruction. The symptoms are more serious, and even threaten the life of patients. It is often necessary to go to the emergency department or respiratory department of the hospital for active rescue and treatment [3]. In adjunct to typical symptomatic treatment such as repeated inhalation of SABA, oral glucocorticoid and anti-asthmatic therapy, oxygen therapy is also a necessary adjuvant therapy [3-4].

Deciding a correct oxygen therapy method is very crucial to decrease the rate of mechanical ventilation and mortality in hypoxemic patients and also for the patient's safety and comfort. High flow nasal cannula (HFNC) oxygen therapy is being commonly accepted as an inventive respiratory support for hypoxemic patients specifically those with acute respiratory failure [5]. High flow nasal oxygen inhalation is a new oxygen therapy method developed in recent years and has been established and widely studied in asthmatic patients in neonatal and pediatric settings. It mixes a certain concentration of oxygen with high flow gas, and directly gives it to patients through an unsealed nasal cannula [6-7]. High flow nasal cannula (HFNC) oxygen therapy comprises of a nasal prong, a single tube (heated), a humidifier, and a gas (air/oxygen) mixer. The inspiratory fraction of oxygen (F_IO_2) at the gas (air/oxygen) mixer is at the setting in the range of 0.21 to 1.0 in a flow of up to 60L/min. The air is heated and humidifier at 37°C with the active humidifier and delivered directly to patients through an unsealed nasal cannula [6-7].

Mechanism of action of HFNC:

The high flow nasal cannula provides medical gas heated to 37 degrees Celsius and 100% relative humidity with a flow rate of 20-60 L/min, which clears the nasopharyngeal dead space, generates muco-ciliary clearance, positive airway pressure and consequently, improve work of breathing and lower respiratory rates [8]. It is suggested that HFNC can provide several benefits. This incorporates lowering anatomical dead space, producing positive end-expiratory pressure (PEEP), retaining constant FiO2, enhancing muco-ciliary clearance and reducing respiratory work. Fully heated and humidified high flow gas can meet the flow demand of hypoxic patients. [8]. The key principle of HFNC oxygen therapy as follows,

- Lowering anatomical dead space
- Nasopharyngeal Clearance
- Constant PEEP
- inspired oxygen being heated and Humidified.
- Constant fraction of inspired oxygen (FiO2)
- Lessening work of breathing

METHODS

PubMed, Geen Medical, Google scholar and Science direct were searched for all relevant previously published articles or abstracts in English. Terms like “Acute asthma exacerbation,” “high flow nasal cannula oxygen,” “asthmatic crisis,” “HFNC in adults,” “HFNC in asthma”, “high flow oxygenation” were used for searching the related articles. In all the related articles the reference list was checked for additional information. The relevance with the topic was reviewed from all the titles and abstracts obtained from the search. Full texts of appropriate abstracts were then reviewed, and the final list of articles was determined for inclusion in the article. The references of all the included studies were also searched to identify potentially relevant citations.

RESULTS

Until mid-December 2020 all the articles/studies (around 11) related to treatment with HFNC vs conventional oxygen therapy (2 studies were related to HFNC vs NIV) were studied which included a total number of 1025 patients. Out of which 260 were taken in the HFNC subgroup, 733 in COT subgroup and 32 in NIV subgroup. Overall results of all the related studies revealed, in the first 2-3 hours of treatment of HFNC compared to COT heart rate, respiratory rate and pulmonary score decreased, over the time in both subgroups HR, RR and PS reached normal range. In the case of FEV1 after 24hours of treatment, both subgroups were improved significantly. Other parameters like blood gas analysis, oxygen saturation did not show any contrast result within these two subgroups. Within all articles studied, only two research studies showed complication concerning use of HFNC. Baudin et al. [9] one patient suffered from pneumothorax after 31 hours with NHF oxygen therapy, requiring a chest tube for 24 hours, and another patient of HFNC subgroup required NIV because of worsening blood gas parameters in the first 24 hours. Morosini et al. [10] a patient suffered from hypertensive pneumothorax after initiation of HFNC. A sum of 3 patients complained of intolerance to HFNC, Rittayamai N et al. [11] has shown a patient withdrew immediately after applying HFNC device due to intolerance. Whereas Sh.Raeisi, et al. [12] uncovered two of the patients from the HFNC subgroup objected from heat and nasal irritation which was induced by device. In the same study, one patient from the COT subgroup experienced from refractory asthma with oxygen saturation of 85% even though receiving standard treatment. In J. Pilar et al. [13] eight patients of the HFNC subgroup required escalation to NIV. Except these studies other studies did not face any complications nor any patients were intubated. In these studies, no deaths were recorded.

		Respiratory Rate		Heart Rate		O_2 Saturation		Length of stay		Mean Arterial Pressure	
		HFNC Mean SD	COT	HFNC Mean SD	COT	HFNC	COT	HFNC	COT	HFNC	COT
R.Gauto Benitez et al	2hr 6hr	38.6 ±10.5 32.0 ± 7.9	39 ± 9.8 35.1± 7.9			97(82-99) 97(88-99)	96(98-100) 96(85-100)	24.8 ± 12.3	24.8 ± 14.8		
F.Gonzalez et al		45(38-56)	40(32-48)	140 (130-146)	133 (120-146)						
Rittayamai N et al		26.0 ± 6.2	27.5 ± 4.9	91.7 ± 19.3	101.6 ± 24.2	96.8 ± 2.5	97.6 ± 2.0			88.7±10.9	101.0 ± 24.8
Baudin et al		40 ± 13	31 ± 8	165 ± 21 (per min)	141 ± 25 (per minute)						
Onlak et al		19.7 ± 2.9	25.1 ± 4.2								

Table 1: lists of collective data published in different journals where HFNC oxygen therapy is compared with COT in different aspect.

DISCUSSION

This Literature review shows that HFNC, as a substitute for COT and NIV, has been used in different ways in asthma patients. In this setting, heart rate, respiratory rate, and pulmonary score decreased in the first 2-3 hours of HFNC treatment, but over the time both subgroups (HFNC and COT/NIV), these parameters reached normal range. In addition, HFNC decreased the work of breathing to the same extent as NIV but increased the work of breathing during COT. As compared to COT and NIV, HFNC has been registered to be more comfortable.

Most recently published pilot randomized controlled trial in patients with asthma and hypoxemia in the emergency department setup, Onlak et al [14] which reported nasal high flow (NHF) could significantly decrease the degree of dyspnea compared with COT assessed primarily by modified Borg scale (MBS) along with numerical rating scale (NRS), dyspnea scale, and respiratory scale at 120mins after initiating treatment.

Nevertheless, there was no evidence of differences in pH and PaCO2 level from arterial blood gas after using the two interventions.

In a pilot study of the high flow oxygen therapy in children with asthma Y. Ballestero et al [15] in the emergency service/ ward published in January 2017, at 2 hours of high flow oxygen therapy there was significant reduction in respiratory work however that did not determine whether the HFNC is better than COT regarding duration of respiratory support. In this study, younger children were analyzed, which may mean there is a greater possibility of coinciding diseases, such as bronchiolitis or viral wheezing. And finally, after use of HFNC no side effects or infections associated with it were reported during this study period. In the adult ward setting In 2019, Sh.Raeisis, et al [12] described in the treatment of moderate to severe asthma exacerbation use of HFNC . This study observed clinical enhancements in both dyspnea score and heart rate. In addition, within the first two hours of treatment, there was an increase in percentage of FEV1 revealed is a higher slope in the HFNC group modified from 2 to 24 hours of experience in both groups. However, improvements in ABG index and O2 saturation were similar in both groups. In COT group, one of the patients developed refractory asthma and required more respiratory support. In HFNC group, 2 patients developed nasal irritation and warmness.

A randomized controlled study conducted in China, Wan ru Geng et al. [16] compared HFNC and COT in adults at ward setting and revealed that HFNC had the same clinical efficacy as COT in patients with severe bronchial asthma complicated with respiratory failure and no substantial differences in tracheal intubation rate and hospital stay between the two groups. A randomized study [10] Showed that in subjects presenting to the emergency department with acute dyspnea and hypoxemia, use of HFNC caused in better comfort and less dyspnea in comparison to COT. This study also suggested applicable selection and frequent reevaluation of patients during HFNC use will help to improve outcomes, particularly in the emergency department. R.Gauto Benitez et al [17] 2019, added HFNC oxygen therapy to the treatment of a patient with severe to moderate asthma(who did not respond to the initial treatment)did not present clinical benefits or reduce the length of stay. None of the patients after the use of HFNC had complications, and none of the patients needed to be admitted to PICU.

One pilot randomized controlled trial [18] in children visiting the emergency department with asthma exacerbation found that NHF could decrease the pulmonary score better than standard oxygen therapy. A retrospective study [19] was conducted from 2012 to 2016 in Spain which concluded HFNC therapy can be the useful in the management of asthma exacerbations in the pediatric ward. Patients with higher severity score and more previous hospitalizations constitute a risk subgroup, which can benefit from respiratory support (hfnc oxygen therapy). Therefore, this study suggests that patients should be monitored more closely from the time of admission. For decades, the use of heated humidified HFNC oxygen therapy has been getting the attention of clinicians on asthmatic patients as an alternative to COT/NIV. However, Physicians have been using HFNC in patients with asthma in neonatal and pediatric settings for more than a decade now. Also, it can be used in adult patients in ward settings. It is much more effective in patients who are contraindicated to

mechanical ventilation, in tolerate COT and NIV, do-not resuscitate and immunocompromised patients. Despite this there are some crucial concerns that remain to be resolved, like absolute indication of HFNC, criteria for timing to start and stopping of HFNC and for escalating treatment.

CONCLUSION

This review study, together with the detailed review of formerly published literature, stipulates valuable information and could lead to a conclusion that as compared to COT/NIV, HFNC used in asthmatic patients seems more comfortable and well tolerated by patients and as well heart rate, respiratory rate and pulmonary score decreased over the time. So, the HFNC oxygen therapy in asthma is being innovative and widely accepted oxygen therapy at present time.

REFERENCES

1. Global Initiative for Asthma, Global Strategy for Asthma Management and prevention: NHLBI/WHO Workshop Report, National Institutes of Health, Bethesda, MD, USA, 2019.
2. K. Huang, T. Yang, J. Xu et al., “Prevalence, risk factors, and management of asthma in China: a national cross-sectional study,” $e Lancet, vol. 394, no. 10196, pp. 407–418, 2019.
3. C. M. Dolan, K. E. Fraher, E. R. Bleecker et al., “Design and baseline characteristics of the epidemiology and natural history of asthma: outcomes and treatment regimens (TENOR) study: a large cohort of patients with severe or difficult-to-treat asthma,” Annals of Allergy, Asthma & Immunology, vol. 92, no. 1, pp. 32–39, 2004.
4. A. M. Fitzpatrick, C. E. Baena-Cagnani, and L. B. Bacharier, “Severe asthma in childhood,” Current Opinion in Allergy and Clinical Immunology, vol. 12, no. 2, pp. 193–201, 2012.
5. Kim ES, Lee H, Kim SJ, Park J, Lee YJ, Park JS, et al. Effectiveness of high-flow nasal cannula oxygen therapy for acute respiratory failure with hypercapnia. J Thorac Dis. 2018 Feb;10(2):882-888.
6. D. Jahagirdar and L. Picheca, “Heated humidified high flow oxygen for respiratory support: a review of clinical effectiveness, cost-effectiveness, and guidelines,” CADTH Rapid Response Reports, Canadian Agency for Drugs and Technologies in Health, Ottawa, Canada, 2019.
7. F. J. Lodeserto, T. M. Lettich, and S. R. Rezaie, “High-flow nasal cannula: mechanisms of action and adult and pediatric indications,” Cureus, vol. 10, no. 11, p. e3639, 2018.
8. Nishimura M, et al. High flow nasal cannula oxygen therapy in adults, J Intensive Care. 2015 Mar 31;3(1):15. doi: 10.1186/s40560-015-0084-5.
9. Baudin F, Buisson A, Vanel B, Massenavette B, Pouyau R, Javouhey E. Nasal high flow in management of children with status asthmaticus: a retrospective observational study. Ann Intensive Care. 2017 Dec;7(1):55.
10. Morosini F, Amarillo P, Alonso B, Prego J. Cánula nasal de alto flujo en niños con crisis asmática en un servicio de urgencias pediátrico. Arch Pediatr Urug [Internet]. 2017;88(3):142-8. Available from:

http://www.scielo.edu.uy/scielo. php?script=sci_arttext&pid=S1688-12492017000300142&lng=en&tlng=en#?

11. Rittayamai N, Tscheikuna J, Praphruetkit N, Kijpinyochai S. Use of High-Flow Nasal Cannula for Acute Dyspnea and Hypoxemia in the Emergency Department. Respir Care. 2015;60:1377–1382.
12. Sh.Raeisi, et al. Value and Safety of High Flow Oxygenation in the Treatment of Inpatient Asthma: A Randomized, Double-blind, Pilot Study. Iran J Allergy Asthma Immunol, December 2019; 18(6):615-623
13. Pilar J, Modesto V, Lopez-fernandez YM, Lopez-macias O. High-flow nasal cannula therapy versus non-invasive ventilation in children with severe acute asthma exacerbation : An observational cohort study. Med Intensiva 2017; 41(7):418–24.
14. Ruangsomboon O, Limsuwat C, Praphruekit Monsomboon A, Chakorn T. Nasal High Flow Oxygen Versus Conventional Oxygen Therapy for Acute Severe Asthma Patients: A Pilot Randomized Controlled trial Acad Emerg Med 2020 Nov 30 DOI: 10.1111/acem.14187
15. Ballestero Y, De Pedro J, Portillo N, Martinez-Mugica O, Arana-Arri E, Benito J. Pilot Clinical Trial of High-Flow Oxygen Therapy in Children with Asthma in the Emergency Service. J Pediatr. 2018;194:204–210.
16. Geng W, Batu W, You S, Tong Z, He H. High-Flow Nasal Cannula: A Promising Oxygen Therapy for Patients with Severe Bronchial Asthma Complicated with Respiratory Failure. Can Respir J. 2020;2020:2301712. Published 2020 Feb 20. doi:10.1155/2020/2301712
17. R.Gauto Benitez, L. Patricia Morilla Sanabria, V. Pavlicich, M. Mesquita. High flow nasal cannula oxygen therapy in patients with asthmatic crisis in the pediatric emergency department. Rev Chil Pediatr 2019;90(6):642-648. DOI:10.32641/rchped.v90i6.1145
18. David MMC, Gomes ELFD, Cavassin CLF, Luiz JG, Andrade MCD, Costa D. Clinical impact of the High-Flow Nasal Cannula in the treatment of asthma crisis in Accepted Article children and adolescents: A pilot study. Eur Resp J. 2019; 54: Suppl. 63, PA1228.
19. González Martínez F, González Sánchez MI, Toledo del Castillo B, Pérez Moreno J, Medina Munoz ˜ M, Rodríguez Jiménez C, et al. Tratamiento con oxigenoterapia de alto flujo en las crisis asmáticas en la planta de hospitalización de pediatría: nuestra experiencia. An Pediatr (Barc). 2019;90:72---78.