Archives of Anesthesiology and Critical Care (Autumn 2024); 10(4): 343-352.

Available online at http://aacc.tums.ac.ir

Research Article

High Flow Nasal Cannula Oxygen Therapy (HFNC) With Different Temperatures in COVID-19 Patients: A Randomized Clinical Trial

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ARTICLE INFO

Article history:
Received 23 August 2023
Revised 14 September 2023
Accepted 28 September 2023

Keywords:
COVID-19;
High flow nasal cannula;
Oxygen therapy;
Hypoxia

ABSTRACT

Background: The effect of using high flow oxygen delivery through the nasal cannula (HFNC) in COVID-19 patients has been associated with different results. This study aimed to evaluate the effect of different HFNC temperatures in COVID-19 patients.

Methods: Patients were randomly divided into three groups under high current oxygenation with temperatures of 31, 34, and 37. Except for the temperature, other device settings were set equally. After 24 hours, clinical conditions were on the agenda and compared with the conditions before the intervention.

Results: Fever, sore throat, malaise, diarrhea in patients of 31 degree group and indicators of nausea, cough, body pain, headache have changed the most in 37 degree group. Abdominal pain has shown the greatest change in the 34 degree group. PR, DBP, and SpO2 indices changed the most at 31 degrees and RR and SBP at 37 degrees. PR, RR, SBP and SPO2 indices showed significant values in intra-group comparison, and in inter-group comparison, only PR, RR indices had significant differences. In intra-group analysis, PaCO2, WBC, CRP, ESR and ferritin had significant changes, and in inter-group comparison, none of the indicators had significant differences.

Conclusion: Based on the results of the present study, reducing the temperature in the use of HFNC can improve the clinical conditions of patients with COVID-19.

Introduction

The outbreak of the infectious agent called SARS-COV-2 at the beginning of 2020 has changed the world community enormously. The consequences of the spread of this pollution, in addition to the loss of lives of countless people around the world, have affected various areas of economic, social, and global health. Despite the focus of many researchers around the world to achieve a successful treatment line for this disease, existing therapies still rely on the use of supportive drugs

The authors declare no conflicts of interest.

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and the use of necessary methods to improve the living conditions of these patients [1].

Since one of the main problems of patients with COVID-19 is the occurrence of respiratory disorders and subsequent lung damage, optimization of current oxygen delivery methods can reduce or prevent many pulmonary complications of this disease [2]. Although the use of oxygen therapy with a nasal cannula and high flow is not very long, studies have shown the use of this method in patients with acute respiratory failure is effective and safe [3]. Comparison of the effectiveness of non-invasive ventilation, conventional oxygen therapy, and HFNC has shown that in the group of patients using HFNC, the need for invasive ventilation was significantly lower than in other groups [4-5]. Also, the 90-day survival rate of these patients was higher than the other two groups. Therefore, the use of HFNC has been confirmed in many cases of acute respiratory failure and has been considered after the outbreak of COVID-19.

The positive effects of HFNC use in various diseases such as hypoxemic respiratory failure, COPD, sleep apnea, and acute heart failure have been demonstrated [6-8]. After the outbreak of COVID-19, attention has been paid to this method of respiratory support, especially in severe patients [9]. Although many studies have been performed on patient comfort when using HFNC compared to other oxygen delivery methods, few studies have addressed the details of patient satisfaction when using this method. This can be effective in creating optimal conditions for the regulation of flow, temperature, and humidity by the HFNC and significantly increase the efficiency of this treatment method. Limited studies have been performed on the effect of temperature regulation changes on HFNC efficiency [10].

In the present study, the effect of HFNC temperature changes on the improvement of clinical conditions and respiratory factors in patients with COVID-19 hospitalization will be evaluated.

Methods

Study design

The present study was performed as a randomized clinical trial without a control group on severe patients admitted to the hospital with the IRCT code IRCT20210061104772N4. Inclusion criteria included evidence of new coronavirus (SARS-CoV-2) (clinical or paraclinical), Saturation<90, written consent to participate in the study, and age over 18 years. Exclusion factors also included pregnant and lactating patients and decreased patient level of consciousness and intolerance of oxygen delivery devices. Preliminary assessments such as review of the patient's medical history, associated factors, medications, clinical symptom monitor, Borg scale, as well as blood gas testing were recorded before the start of the treatment process. During the treatment period of receiving remdesivir, according to the clinical condition and the prescription of the relevant physician, patients were divided into three groups based on a simple randomization method with the help of codes assigned to each patient. In the first group, oxygenation with HFNC was set at 31 ° C, in the second group at 34 ° C and in the third group at 37 ° C. Also, the flow of oxygen to the patient was adjusted in all three groups and was 40 liters per minute. Before starting oxygen therapy, the patient was taught how to breathe properly. Except for the temperature, the other settings of the device were the same for all patients and during the use of the device, the patient's clinical condition and satisfactory breathing were closely monitored. Patients received high-flow oxygen for 24 hours through the nasal cannula (HFNC) (Fisher & Paykel). Clinical conditions, blood gas analysis, and laboratory tests were evaluated and analyzed before receiving HFNC, after 24 hours, and also 7 days later.

Statistical Analysis

All quantitative variables as a mean and standard deviation; and qualitative variables were expressed as number (percentage). The normality of the quantitative variables was evaluated by the Kolmogorov-Smirnov test and box diagrams and the probability of normality. All statistical tests were analyzed in two domains with a significance level of 5% using SPSS 21 software.

Results

During the study period, 30 patients with moderate to severe COVID-19 were treated with a high flow nasal cannula oxygen delivery system (Figure 1). The mean age of participants was 52.57 years, while 63.33% (19 patients) were men and 36.7% (11 patients) were women. Demographic information and baseline conditions of patients are presented in (Table 1). The prevalence of fever in patients included in the study with 76.7% was the highest among all patients.

Based on the results in (Table 2), the comparison of demographic indicators and patient records in the three groups did not show a significant difference ($p> 0.05$).

Based on the results obtained from (Table 3), the indices of fever, sore throat, malaise, and diarrhea in the patients of the 31 degree group and the indices of nausea, cough, body pain, and headache in the patients of the 37 degree group have changed the most. Meanwhile, the abdominal pain index has shown the greatest change in the 34 degree group. It should be noted that the indicators of smell and taste disorders did not change under the influence of HFNC temperature.

The changes in clinical symptoms including fever, nausea, cough, sore throat, body pain, abdominal pain, malaise, and diarrhea were significantly different before and after the treatment, which shows that the treatment has been effective in improving the symptoms. On the other hand, the analysis of inter-group changes showed that among the examined clinical symptoms, fever, sore

throat, headache, and malaise had significant differences (Table 4).

Examining the hemodynamic indices of the three groups of patients under study showed that the PR, DBP, and SpO2 indices changed the most at 31 degrees, and the RR and SBP indices changed the most at 37 degrees (Table 5).

Intra-group examination and inter-group comparison of the hemodynamic indices of the studied patients show that the PR, RR, SBP and SPO2 indices show significant values in the intra-group comparison. This is despite the fact that in the inter-group comparison, only the PR and RR indices were significantly different (P<0.05) (Table 6).

The results obtained from the blood gas analysis and laboratory tests of the patients in the three groups under investigation showed that in the intra-group analysis, PaCO2, WBC, CRP, ESRand ferritin had significant changes. This is despite the fact that none of the indicators show a significant difference in the inter-group comparison (Table 7).

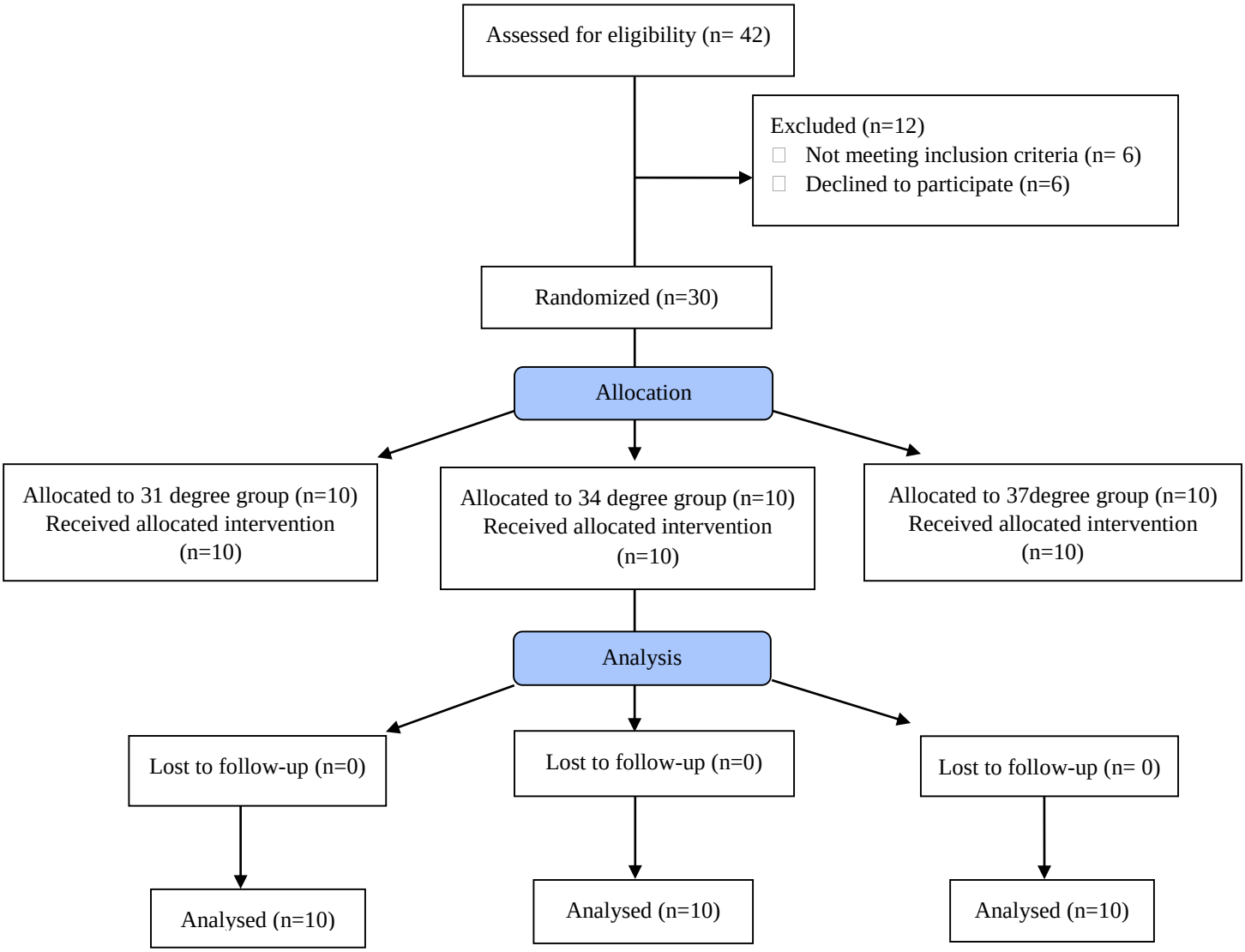

Figure 1- Diagrams of patients participating in the study

Table 1- Demographic conditions of patients by study groups

	Mean ± S. D	**Min- Max**
Age	52.57 ± 12.54	32- 82
Weight	82.73 ± 15.01	55-112
Height	168.40 ± 11.60	144-186

BMI	29.15	21.4-36.5
Hospital Stay	11.40	5-29.0
Flow	40.00	_
	N (%)	
Female	11(36.7)	
Diabetics	18(60)	
HTN	11(36.7)	
COPD	4 (13.3)	
Smoking	9(30)	
Drugs	10 (33.3)	
Alcohol	2 (6.7)	
Malignancies	2(6.7)	
Fever	23 (76.7)	

Table 2- Demographics and patient history in three groups

temp(groups)		**31.0**	**34.0**	**37.0**	**P value**
Age		53.3 ± 9.2	52.7 ± 12.6	51.7 ± 16.2	0.962
BMI		28.5 ± 4.7	31.1 ± 2.9	27.8 ± 4.3	0.185
Hospital Stay		13.0 ± 8.5	9.5 ± 2.8	11.7 ± 3.4	0.370
Sex	Female	3 (27.3%)	5(45.5%)	3(27.3%)	
	Male	7(36.8%)	5(26.3%)	7(36.8%)	0.563
Diabetics	Positive	6 (60%)	6 (60%)	6 (60%)	_
	Negative	4 (40%)	4 (40%)	4 (40%)	
HTN	Positive	6 (60%)	2 (20%)	3 (30%)	0.155
	Negative	4 (40%)	8 (80%)	7 (70%)	
COPD	Positive	2 (20%)	0	2 (20%)	0.315
	Negative	8 (80%)	10(100%)	8(80%)	
Smoking	Positive	3 (30%)	3 (30%)	3 (30%)	
	Negative	7 (70%)	7 (70%)	7 (70%)	-
Drugs	Positive	4 (40%)	1(10%)	5 (50%)	
	Negative	6 (60%)	9 (90%)	5 (50%)	0.142
Alcohol	Positive	0	0	2 (20%)	
	Negative	10 (100%)	10(100%)	8 (80%)	0.117
Malignancies	Positive	2 (20%)	0	0	
	Negative	8 (80%)	10 (100%)	10 (100%)	0.117
Fever	Positive	8 (80%)	6(60%)	9(90%)	
	Negative	2(20%)	4(40%)	1(10%)	0.271

Table 3- Changes in clinical symptoms during 7 days

Variable (%)		**Before**	**1st day**	**2st day**	**3st day**	**4st day**	**5st day**	**6st day**	**7st day**
Fever	37	9 (90%)	9 (90%)	9	7	5	5	5	4
	34	6 (60 %)	5 (50%)	5	4	3	1	0	0
	31	8 (80 %)	8 (80%)	8	6	4	1	1	1
	Total	23 (76.7%)	22 (73.3%)	22 (73.3%)	17 (56.7%)	12 (40%)	7 (23.3%)	6 (20%)	5 (16.7%)
Nausea	37	4 (40%)	4 (40%)	4	4	1	0	0	0
	34	6 (60%)	6 (60%)	6	2	2	1	0	0
	31	6 (60%)	6 (60%)	6	4	2	2	0	0
	Total	16 (53.3%)	16 (53.3%)	16 (53.3%)	10 (33.3%)	5 (16.7 %)	3 (10%)	0 (0%)	0 (0%)

Cough	37	9 (90 %)	9 (90%)	8	6	5	4	4	3
	34	4 (40%)	4(40%)	4	3	3	1	1	1
	31	7 (70 %)	7 (70%)	7	6	7	6	5	5
	Total	20 (66.7%)	20 (66.7%)	19 (63.3%)	15 (50%)	15 (50%)	11 (36.7%)	10(33.3%)	9 (30%)
Sore throat	37	7 (70%)	7	6	6	5	4	3	3
	34	3 (30%)	3	3	3	2	0	0	0
	31	3 (30%)	3	2	1	0	0	0	0
	Total	13 (43.3%)	13 (43.3%)	11 (36.7%)	10 (33.3%)	7 (23.3%)	4 (13.3%)	3 (10%)	3 (10%)
Body pain	37	9 (90 %)	9	9	5	2	2	2	2
	34	10 (100%)	10	10	8	6	6	4	4
	31	9 (90%)	9	9	9	9	9	7	7
	Total	28 (93.3%)	28 (93.3%)	28 (93.3%)	22 (73.3%)	17(56.7%)	17 (56.7%)	13(43.3%)	13(43.3%)
Abdominal pain	37	1 (10%)	1	1	0	0	0	0	0
	34	4 (40%)	4	3	2	2	1	1	1
	31	2 (20%)	1	1	0	0	0	0	0
	Total	7 (23.3%)	6 (20%0	5 (16.7)	2 (6.7%)	2 (6.7%)	1 (3.3%)	1 (3.3%)	1 (3.3%)
Headache	37	10 (100%)	10	10	9	7	5	5	0
	34	10 (100%)	9	5	5	4	3	2	0
	31	10 (100%)	8	4	2	2	0	0	0
	Total	30 (100%)	28(93.3%)	19(63.3%)	16(53.3%)	13(43.3%)	8(26.7%)	7(23.3%)	0(0%)
Malaise	37	10 (100%)	10	10	10	10	10	10	10
	34	10 (100%)	10	10	10	9	9	9	9
	31	10 (100%)	10	9	9	7	7	7	5
	Total	30 (100%)	30(100%)	29(96.7%)	29(96.7%)	26(86.7%)	26(86.7%)	26(86.7%)	24 (80%)
Diarrhea	37	1 (10%)	1	1	0	0	0	0	0
	34	2 (20%)	2	1	0	0	0	0	0
	31	3 (30%)	3	3	3	0	0	0	0

	Total	6 (20%)	6 (20%)	5 (16.7%)	3 (10%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Taste disorders	37	7 (70%)	7 (70%)	7	7	7	7	7	7
	34	5 (50%)	5 (50%)	5	5	5	5	5	5
	31	8 (80%)	8 (80%)	8	8	8	8	8	8
	Total	20 (66.7%)	20 (66.7%)	20 (66.7%)	20 (66.7%)	20 (66.7%)	20 (66.7%)	20 (66.7%)	20 (66.7%)
Olfactory disorders	37	7 (70%)	7	7	7	7	7	7	7
	34	4 (40%)	4	4	4	4	4	4	4
	31	8 (80%)	8	8	8	8	8	8	8
	Total	19 (63.3%)	19 (63.3%)	19 (63.3%)	19 (63.3%)	20 (63.3%)	19 (63.3%)	19 (63.3%)	19 (63.3%)

Table 4- Intragroup and intergroup comparison of clinical symptoms

Variable	Before and after treatment (Wilcoxon test) P value	Between group (Kruskal-Wallis test) P value
Fever	0.000	0.04
Nausea	0.000	0.1
Cough	0.002	0.15
Sore throat	0.002	0.04
Body pain	0.000	0.08
Abdominal pain	0.014	0.36
Headache	0.000	0.03
Malaise	0.014	0.01
Diarrhea	0.014	1
Taste disorder	1	0.3
Olfactory disorder	1	0.16

Table 5- Comparison of hemodynamic indicators in patients by study groups

Variable		Before	1st day	2st day	3st day	4st day	5st day	6st day	7st day
	37	85.9 ± 9.9	84.2 ± 7.1	84.1 ± 7.7	83.8 ± 7.6	82 ± 7.2	80.5 ± 6.4	80.5 ± 6.4	80.5 ± 6.4
PR	34	101.2 ± 16.3	98.9 ± 16.07	96.1 ± 15	94.6 ± 14	94.5 ± 14.1	92.5 ± 13.1	92.5 ± 13.1	92.5 ± 13.1
	31	104.4 ± 12.5	103.1 ± 11.2	98.2 ± 9.8	95 ± 10.1	91.4 ± 6.6	91.4 ± 6.6	89.7 ± 5.2	89.7 ± 5.2
	Total	97.1 ± 15.1	95.4 ± 14.2	92.8 ± 12.6	91.1 ± 11.7	89.3 ± 11.02	88.1 ± 10.5	87.5 ± 10.1	87.5 ± 10.1
	37	24.3 ± 4.6	24.3 ± 4.6	22.8 ± 3.5	20.6 ± 3.5	20.3 ± 3.4	20.3 ± 3.5	20.3 ± 3.5	20.3 ± 3.5
RR	34	23.1 ± 5.7	22.2 ± 4.7	21 ± 4.3	20.4 ± 4.06	21.2 ± 4.8	20 ± 3.6	20 ± 3.6	20 ± 3.6
	31	20.8 ± 1.8	20.5 ± 1.7	20.3 ± 1.8	19.3 ± 2.3	17.8 ± 1.1	17.4 ± .96	17.4 ± .96	17.4 ± .96
	Total	22.7 ± 4.4	22.3 ± 4.1	21.3 ± 3.4	20.1 ± 3.3	19.7 ± 3.6	19.2 ± 3.1	19.23 ± 3.1	19.2 ± 3.1
	37	125.6 ± 14.6	125.3 ± 14.6	125.3 ± 14.6	124.8 ± 13.9	124 ± 12.6	124 ± 12.6	124 ± 12.6	124 ± 12.6
SBP	34	121.1 ± 15.2	121.1 ± 15.2	120.3 ± 13.7	120 ± 13.1	120 ± 13.1	120 ± 13.1	120 ± 13.1	120 ± 13.1
	31	134.8 ± 16.1	131.8 ± 14.6	130.5 ± 13.6	130.5 ± 13.6	128.5 ± 12.7	130.3 ± 12.6	130.3 ± 12.6	130.3 ± 12.6
	Total	127.1 ± 15.8	126 ± 14.9	125.3 ± 14.1	125.1 ± 13.8	124.1 ± 12.8	124.7 ± 13	124.7 ± 13	124.7 ± 13

	37	71.5 ± 7.8	71.5 ± 7.8	71.5 ± 7.8	71.5 ±7.8	71 ± 7.7	72 ± 7.1	72 ± 7.1	72 ± 7.1
DBP	34	70.5 ± 6.4	71 ± 5.6	71 ± 7.3	71 ± 7.3	71 ± 7.3	71 ± 7.3	71 ± 7.3	71 ± 7.3
	31	76.8 ± 6.2	76.3 ± 3.1	75.5 ± 5.5	75.5 ± 5.9	74 ± 3.9	73.5 ± 4.1	73.5 ± 4.1	73.5 ± 4.1
	Total	72.9 ± 7.2	72.9 ± 6.1	72.6 ± 7.03	72.6 ± 7.1	72 ± 6.5	72.1 ± 6.2	72.1 ± 6.2	72.1 ± 6.2
	37	79.1 ± 5.2	86.6 ± 5.4	90 ± 4.1	92.1 ± 3.6	93.2 ± 3.3	94.2 ± 2.5	94.4 ± 2.5	94.4 ± 2.5
SPO2	34	75.8 ± 6.01	83.5 ± 5.5	87.7 ± 3.2	90.6 ± 3.1	93.3 ± 3.4	93.9 ± 1.9	93.9 ± 1.9	93.9 ± 1.9
	31	78.6 ± 5.08	82.2 ± 5.6	87.7 ± 3.3	89.6 ± 4.4	91.9 ± 4.5	93 ± 3.09	93.3 ± 2.9	93.6 ± 3.1
	Total	77.8 ± 5.4	84.1 ± 5.6	88.4 ± 3.6	90.7 ± 3.7	92.8 ± 3.7	93.7 ± 2.5	93.8 ± 2.4	93.9 ± 2.5

Table 6- Intragroup and intergroup comparison of hemodynamic indices

Variables		Mean ± SE	ANOVA repeated measures (3×8) Within groups			Between groups		
			F	P	Effect size (Eta square)	F	P	Effect size (Eta square)
	37	74.9 ± 1.8	34.34	0.000	.83	5.24	0.01	0.63
PR	34	95.35 ± 4.37						
	31	94 ± 2.04						
	37	29.17 ± 1	302	0.000	0.97	27.01	0.000	0.75
RR	34	20.98 ± 1.28						
	31	18.86 ± .22						
	37	124.6 ± 4.2	2.95	0.01	0.24	1.37	0.27	0.13
SBP	34	120.3 ± 4.3						
	31	130.8 ± 4.04						
	37	71.6 ± 2.3	1.34	0.24	0.13	0.9	0.42	0.09
DBP	34	70.9 ± 2.2						
	31	74.8 ± 1.2						
	37	90.5 ± .9	132	0.000	0.93	1.04	0.37	0.10
SPO2	34	89.07 ± .78						
	31	88.7 ± 1.03						

Table 7- blood gas analysis and laboratory tests

Variables		1st (m ± SD)	3st (m ± SD)	Delta (m)	Effect	T test (before and after HFNC, total)		ANOVA one way (between groups, before and after HFNC)	
						F	P value	F	P value
	37	43.4 ± 8.7	40.3 ± 7.09	3.11	Decrease	2.81	0.009	0.02	0.97
PaCO2	34	46 ± 4.2	42.4 ± 4.2	3.65					
	31	43.1 ± 8.7	38.9 ± 6.9	3					
	Total	44.2 ± 7.3	40.5 ± 6.2	3.26					
	37	1.05 ± .09	1.01 ± .07	.04	Decrease	2.21	0.03	2.05	0.14
Cr	34	1.29 ± .58	1.05 ± .29	.24					
	31	1.11 ± 29	1.07 ± .13	.04					
	Total	1.15 ± .38	1.04 ± .18	.10					
	37	7 ± 3.8	8.5 ± 1.6	1.53	Increase	-2.99	0.006	.06	0.94
WBC	34	6.5 ± 2.8	8.5 ± 2.8	2.06					
	31	8.6 ± 3.03		1.75					
	Total			1.78					

		7.4 ± 3.3	10.4 ± 3.7						
			9.1 ± 2.9						
	37	285.7 ± 78.4	151.2 ± 97.9	101.2 101.1	Decrease	1.7	0.1	2.77	0.08
IL- 6	34								
	31	220.6 ± 21.2	108.6 ± 61.6	47 53					
	Total	93.2 ± 38.8	116.5 ± 76.9						
		200.7 ± 21.06	125.4 ±59.3						
	37	27 ± 18.2	20 ± 16.2	9.11 8.11	Decrease	3.2	0.004	1.26	0.3
CRP	34								
	31	25.09 ± 12.1	20.12 ± 8.62	22 12					
	Total	48.4 ± 21.7	22.3 ± 16.8						
		33 ± 20.02	20.8 ± 14.07						
	37	49.5 ± 33.6	29.1 ± 19.5	20.4 28.8	Decrease	7.3	0.000	0.82	0.45
ESR	34								
	31	45.88 ± 19.29	14.4 ± 12.5	30.6 26.3					
	Total	54.6 ± 38.05	22.6 ± 15.6						
		50.1 ± 30.8	22.03 ± 12.8						
	37	1044 ± 559	742 ± 514	3.01 2.75	Decrease	6.2	0.000	0.39	0.67
Ferritin	34								
	31	964 ± 677	689 ± 451	2.11 2.62					
	Total	1015 ± 404	804 ± 297						
		1008 ± 539	745 ± 418						
	37	71 ± 48	51.6 ± 26.5	12.3 19.5	Decrease	1.2	0.15	0.74	0.48
ALT	34								
	31	54.7	42.8 ± 22.5	1.6 10.39					
	Total	53.7 ± 39.7	46.1 ± 21.6						
		62.3 ± 46.7	46.7 ± 23						
	37	84.2 ± 46.5	50 ± 25.1	34.2 32.1	Decrease	1.8	0.07	2.66	0.08
AST	34								
	31	70.5 ± 40.75	38.4 ± 16.8	2.5 24.39					
	Total	69.9 ± 29.6	41.5 ± 11.5						
		74.8 ± 48.3	43.4 ± 19.1						
	37	565 ± 333	618 ± 460	22.2 53.2	Decrease	-0.5	0.6	0.55	0.58
D-	34								
dimer	31	960 ± 564	968 ± 315	3.27 83.8					
	Total	1271 ± 441	866 ± 249						

		919 ± 367	819 ± 378						
	37	885 ±	889 ±	3.7	Decrease	-0.18	0.8	0.03	0.97
LDH	34	305	345	40.6					
	31	831 ±	790 ±	5.4					
	Total	396	396	14.1					
		858 ± 165	852 ± 376						
		858 ± 294	844 ± 362						
	37	39.6 ±	35.4 ±	4.2	Decrease	-1.63	0.11	0.74	0.48
BUN	34	12.8	11.7	.8					
	31	36.6 ±	35.8 ±	7.6					
	Total	13.6	8.1	4.06					
		37.6 ± 17.2	30 ± 11.7						
		38 ± 14.2	33.7 ± 10.6						

Discussion

The present study compares the effect of different temperatures on the clinical parameters of patients with COVID-19 in need of supplemental oxygen through HFNC. With the outbreak of COVID-19, concerns were raised about choosing the appropriate approach to manage patients' hypoxia. Among oxygen delivery methods, HFNC is more tolerable for patients with severe respiratory failure [11]. The alveolar membrane is a structure that optimizes respiratory conditions through the isotherm of body heat (37° C) and breathing air [12]. Thus, respiratory support that is more consistent with this condition will be associated with increased comfort and potentially with reduced non-physiological mechanisms (such as inflammation, decreased immunity, altered airway patency) [13].

Unlike conventional cold and dehydrated oxygen therapy, HFNC can deliver a moist, heated combination of oxygen to the alveoli [14]. One of the functions of the upper respiratory tract is to deliver hot, moist, particle-free gas to the alveoli [15]. During inhalation, heat and water are transferred from the mucosa of the respiratory tract to the gas by convection and evaporation. During exhalation, heat, and water vapor return from the alveolar gas to the mucosa of the respiratory tract [16]. This process is designed to protect the lungs and keep the body warm. When the blown air is humid and above body temperature, the patient heats up and speeds up metabolism and oxygen consumption [17]. The use of HFNC for oxygen delivery appears to be an improved intervention with better thermal control and humidity of the inhaled gas [18]. The pattern and its effect in vivo must be evaluated before HFNC can be used.

Based on the results of this study, which evaluated the effect of different temperatures on improving the clinical condition of patients undergoing HFNC; It was shown that among the measured parametric indices, HR and RR were significantly affected by temperature changes (they were significant between different groups). On the other hand, the indicators of fever, sore throat, headache and malaise with HFNC were significantly significant between different groups.

In our study, among the variables that underwent significant changes under the influence of HFNC temperature, RR and SPO2 index have more clinical value in coronary patients. The average changes of these indices at a temperature of 31 degrees had the best recovery result. Therefore, the temperature of HFNC at 31 degrees seems more favorable. However, similar studies in the past have come with different results.

In line with the results of our study, in 2018, Mauri and her colleagues, by examining the temperature and flow changes of HFNC in patients with acute hypoxemic failure, found that in equal oxygen flow, lower temperature is associated with greater patient comfort [19]. On the other hand, Chang and colleagues in 2011 evaluated the effect of oxygen flow on temperature, humidity, pressure and resistance in CPAP and HFNC [20]. According to this research, the optimal temperature when using HFNC was 34 degrees Celsius.

Previous studies have shown that optimizing the intensity of current, humidity and temperature used in HFNC increases the rate of improvement in clinical indicators of patients [21]. However, it should be noted that the rate of optimization of these indicators in different patients is different depending on the clinical condition of the patients and the generalization of the results of this study to all patients is not absolute and the diagnosis of the specialist doctor and the condition of the patient is decisive.

Conclusion

Based on the results of the present research, it can be said that reducing the temperature in the use of HFNC can improve the clinical conditions of patients. Complementary studies with a larger statistical population can provide more convincing and reliable results.

Acknowledgment

This study was carried out with the approval of the ethics committee of Shahid Beheshti University, Tehran, Iran with the code IR.SMBU.NRITLD.REC.1399.221. The authors thank all the people who contributed to this project.

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