文献精读

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Nasal High-Flow versus Venturi Mask Oxygen Therapy after Extubation

Effects on Oxygenation, Comfort, and Clinical Outcome

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Background

- Oxygen is commonly administered after extubation.
- Several devices for oxygen delivery are available in critically ill patients, such as high-concentration reservoir mask, simple face mask, Venturi mask, and nasal cannula
- The Venturi mask is frequently used because it allows delivery of predetermined, nominal FiO_2
- However, Using Venturi mask may be not the best choice for oxygen delivery after extubation

Features of Venturi mask

- low-flow systems
- provides oxygen at flow rates that are lower than patients' inspiratory demands
- Th[illegible] the patient can be lower than the set FIO_2 ($FIO_{2\,SET}$) and depends on the ventilatory demands of the patient
- may also reduce patient comfort because of insufficient humidification: dryness, pain
- more likely to be displaced by the patient than nasal cannula

Do we have alternative choice?

Nasal fully humidified, high-flow oxygen delivery device

- through a nasal cannula
- provides a constant FIO2
- the final concentration of oxygen truly delivered to the patient is equivalent to the $FIO_{2\ SET}$

Nasal fully humidified, high-flow oxygen delivery device

- provide a flow-dependent effect of continuous positive airway pressure
- the high gas flow may generate an upper airways deadspace washout effect and may create an oxygen reservoir within the upper airways

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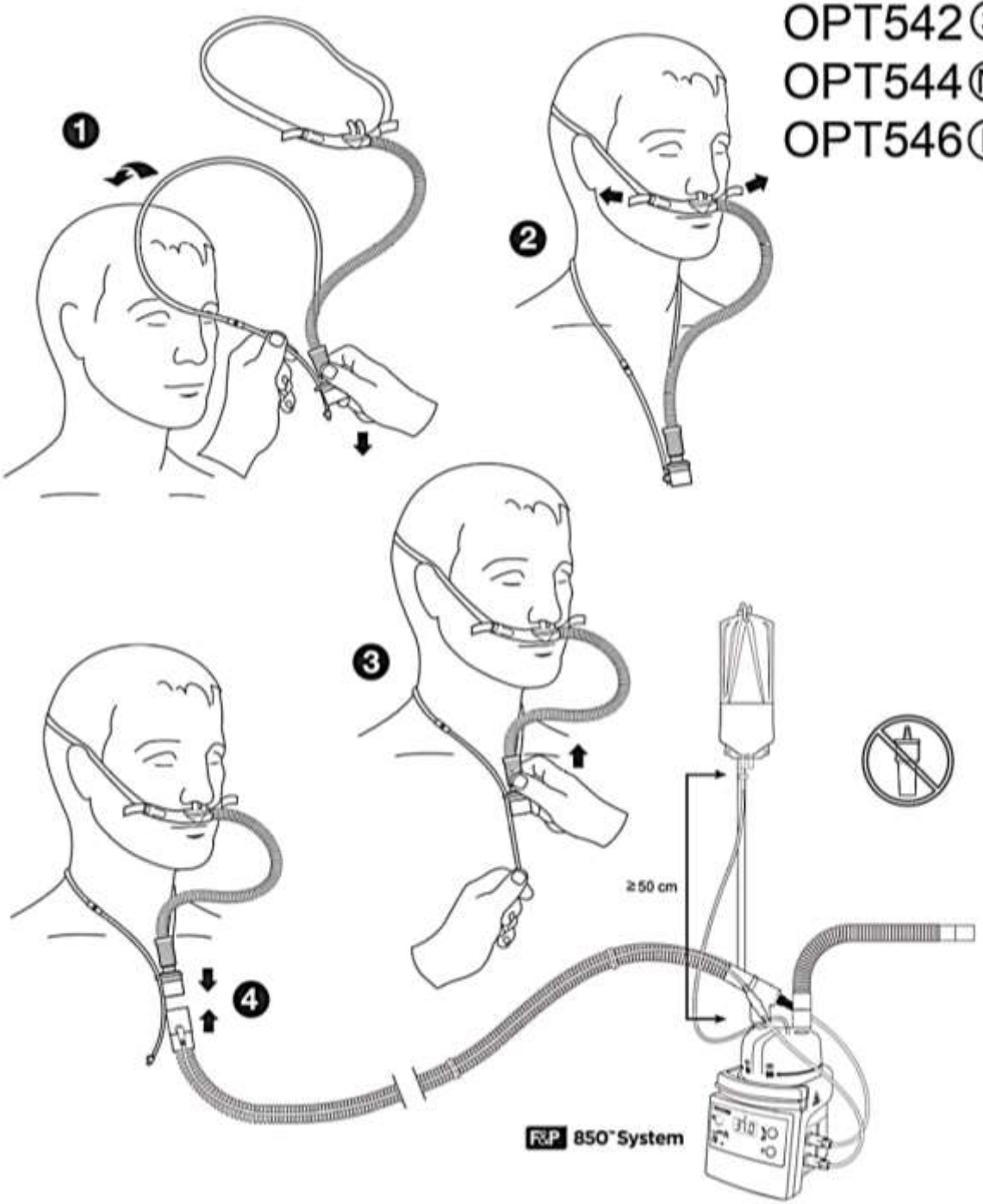


Which one is better?

Nasal high-flow (NHF) device

OR

Conventional low-flow system

Objectives

- To compare the effects of the Venturi mask and the nasal high-flow(NHF) therapy on $PaO2/FIO2_{SET}$ ratio after extubation
- Secondary endpoints were to assess effects on patient discomfort, adverse events, and clinical outcomes

Hypothesis

- Compared to Venturi mask, Nasal high-flow device could improve oxygenation in critical ill patients

Methods

Study design

- Randomized, controlled, open-label trial
- two Italian ICUs (Rome and Novara)
- 105 patients (n=52 for Venturi mask and n=53 for NHF device)
- Patients mechanically ventilated for more than 24 hours were screened for enrollment
- devices were applied for 48 hours postextubation

Inclusion criteria

- successfully passed a spontaneous breathing trial
- had a PaO2/FiO_2 less than or equal to 300 at the end of the spontaneous breathing trial preceding extubation
- including patients with compensated hypercapnia & a respiratory rate ≤25/min at the end of the spontaneous breathing trial

Exclusion criteria

- age less than 18
- pregnancy
- tracheostomy
- do-not-intubate status

Exclusion criteria

- planned use of noninvasive ventilation (NIV) after extubation
  - more than three consecutive failures of the spontaneous breathing trial
  - a PaCO2 greater than 45 mm Hg with a respiratory rate greater than 25 per minute just before the spontaneous breathing trial

Protocol

Weaning

Spontaneous breathing trial

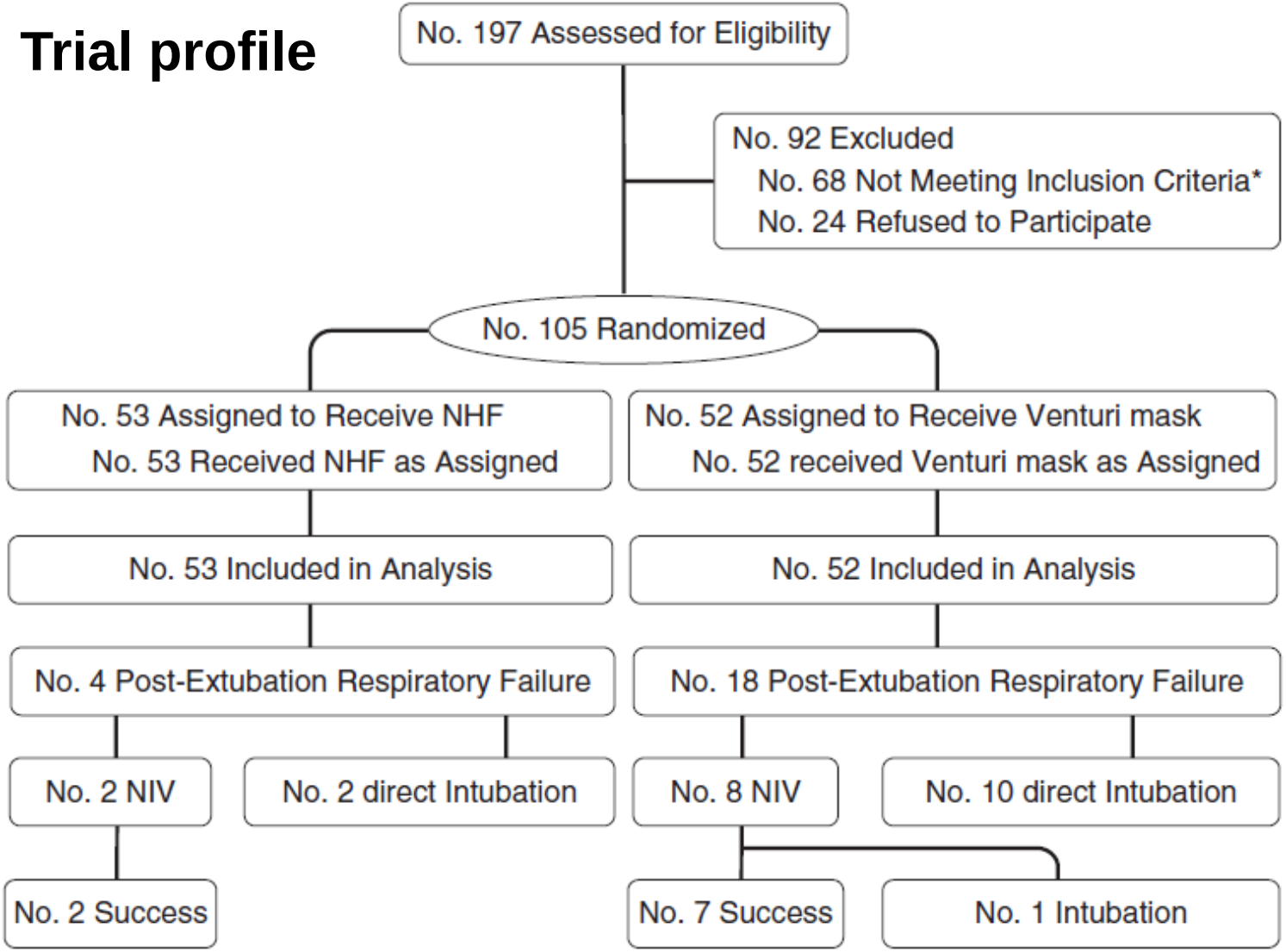
Extubation

Randomization

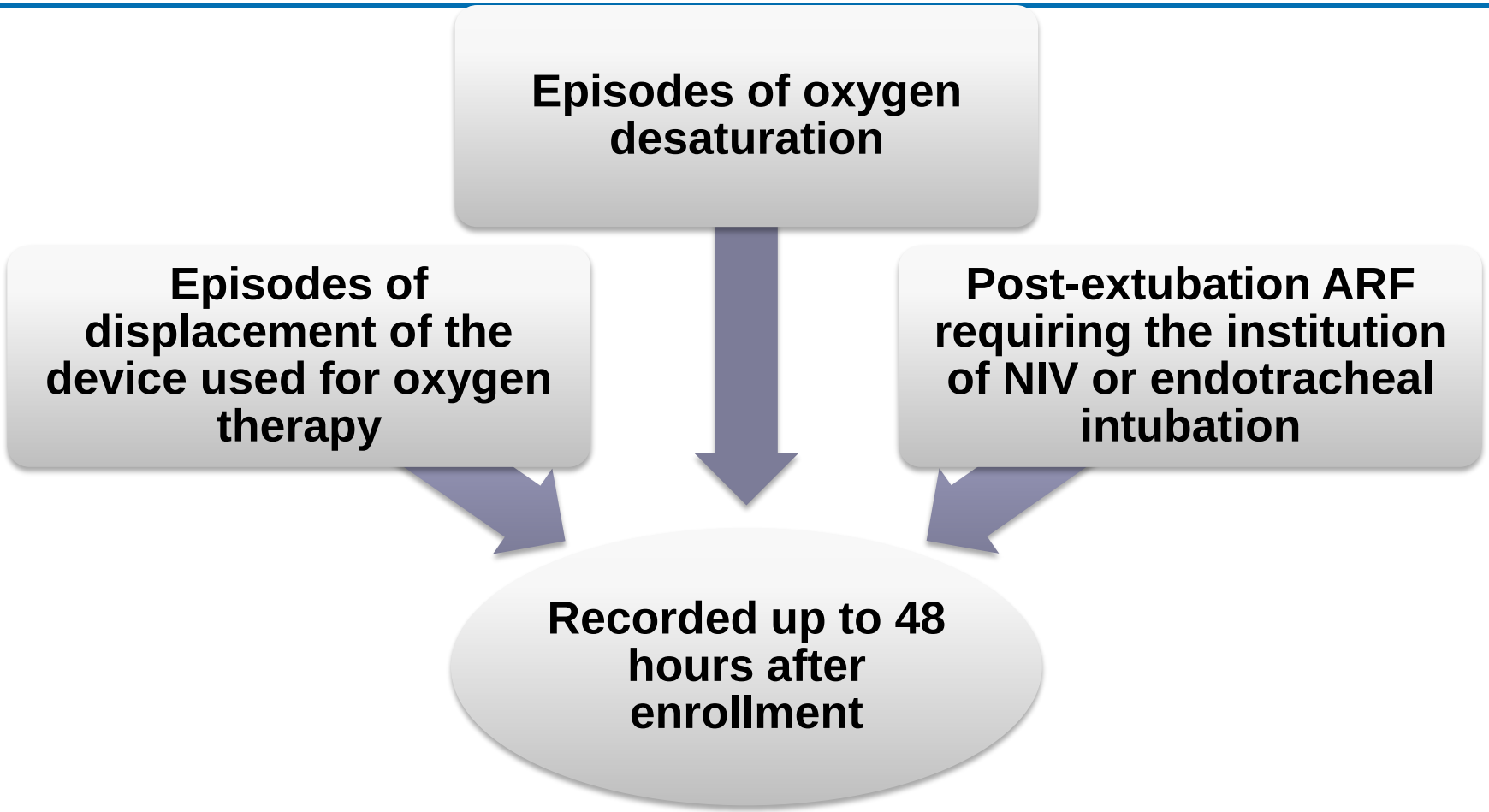
Protocol

- In both groups, $FIO2_{SET}$ was adjusted to obtain an SaO2 between 92% and 98% (88–95% in patients with compensated hypercapnia).
- With NHF, the gas flow rate was 50 L/min.
- The Venturi mask or the NHF were applied for 48 hours or up to ICU discharge.

Trial profile



Measurements: adverse events



Measurements: applying NIV

hypercapnia with respiratory acidosis (PaCO2 >45 mmHg with an arterial pH <7.35)

clinical signs suggestive of respiratory muscle fatigue or increased respiratory effort

Applying NIV (with 2 or more conditions)

respiratory rate >35 breaths/min for 1h

persistent hypoxemia, defined as a SaO2 <90% or PaO2 <80 mmHg with FiO2SET >50% for more than 1h

Measurements: endotracheal intubation

1. hypercapnia with severe respiratory acidosis (PaCO2 >45 mmHg with arterial pH <7.25 and below the value at enrolment)
2. changes in mental status, making nursing care impossible or requiring sedation
3. decrease in SaO2 <85% or PaO2 <45 mmHg despite oxygen therapy (with FiO2SET >50%);
4. unbearable dyspnea with respiratory muscle failure
5. hypotension, with a systolic blood pressure <70 mmHg for more than 30-min despite adequate volume challenge, use of vasopressors, or both;
6. unmanageable copious secretions

Sample size calculation

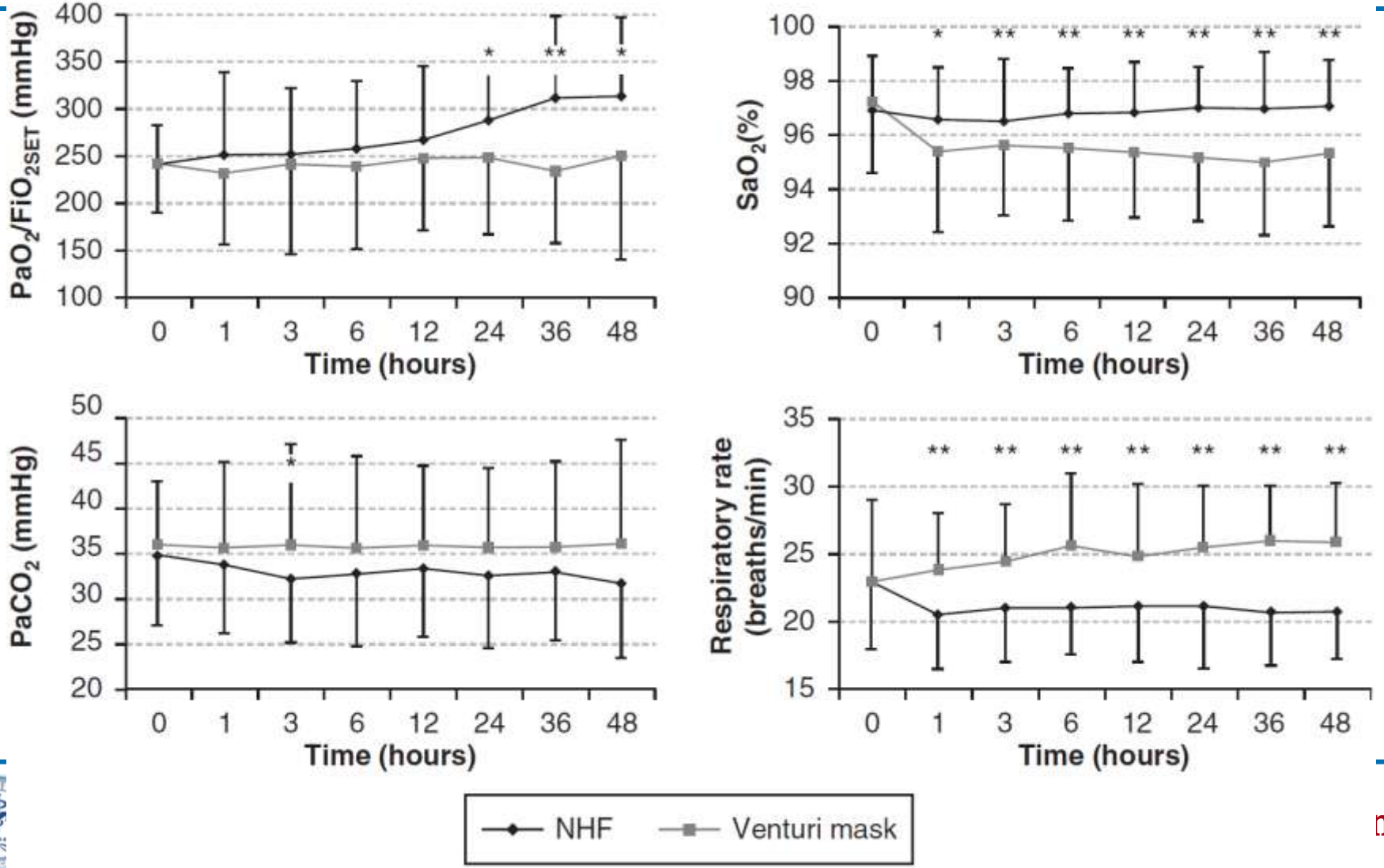
al. (7). These authors reported in fact the lowest improvement in oxygenation with NHF (31 mmHg), coupled with the highest estimate of variance (standard deviation of the observations: 56 mmHg) (7). Based on the results of this analysis, we hypothesized that NHF would produce an increase in $PaO2/FiO2_{SET}$ of at least 31 mmHg at 24 hours, as compared to the Venturi mask. Further, we hypothesized that the attrition rate to be essentially zero, given the experimental set-up (essentially all patients enrolled would be assumed to complete the study). With a common standard deviation of the observations of 56 mmHg, a Type 1 error level of 0.05, a power of 80% and an attrition rate of zero we calculated an overall sample size of 104 patients in two equal arms of 52 patients each.

Results

Characteristics of Patients at Inclusion

	Control Group (*n* = 52)	NHF (*n* = 53)	*P* Value
Age, yr	64 ± 17	65 ± 18	0.9
Male sex, n (%)	35 (67.3)	33 (62.3)	0.73
SAPS II	44 ± 16	43 ± 14	0.73
Type of admission			0.5
Medical, n (%)	31 (60)	35 (66)	
Surgical-trauma, n (%)	21 (40)	18 (34)	
Cause of acute respiratory failure			0.78
Pneumonia, n (%)	24 (46.2)	24 (45.3)	
Multiple trauma, n (%)	12 (23.1)	11 (20.8)	
Atelectasis, n (%)	5 (9.6)	4 (7.5)	
Shock, n (%)	3 (5.8)	5 (9.4)	
Cardiogenic pulmonary edema, n (%)	3 (5.8)	3 (5.7)	
Cardiac arrest, n (%)	2 (3.8)	3 (5.7)	
Other, n (%)*	3 (5.8)	3 (5.7)	
Length of mechanical ventilation before inclusion, d	5.2 ± 3.7	4.6 ± 4.1	0.43
Length of ICU stay before inclusion	5.6 ± 4.4	5.2 ± 4.4	0.67
Pa_{O_2}, mm Hg	93.4 ± 24.2	89.9 ± 19.5	0.41
Pa_{CO_2}, mm Hg	36 ± 7.1	34.7 ± 7.6	0.36
Sa_{O_2}, %	97.2 ± 2.6	96.9 ± 2.0	0.71
FI_{O_2}, %	39 ± 7	38 ± 7	0.47
Pa_{O_2}/FI_{O_2}, mm Hg	241.7 ± 51.1	239.4 ± 42.4	0.8
Respiratory rate, breaths/min	23 ± 6	23 ± 5	0.73
Heart rate, beats/min	91 ± 15	92 ± 19	0.84
Mean arterial pressure, mm Hg	94 ± 15	94 ± 12	0.88

Respiratory and Hemodynamic Parameters



Patient Discomfort

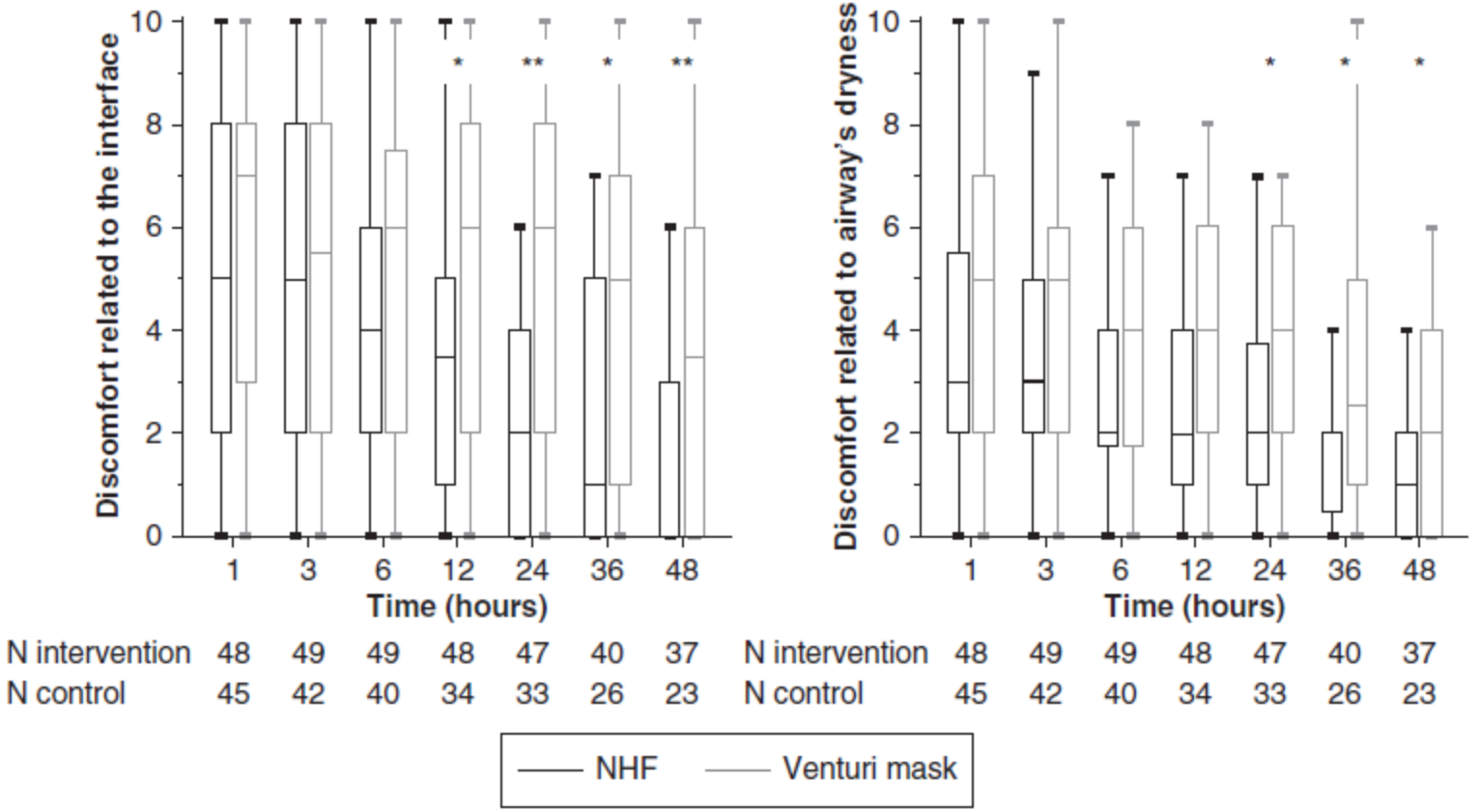


Figure 3. Box and whisker plots of patient discomfort related to the interface (*left*) and related to symptoms of airways dryness (*right*) with the nasal high-flow (NHF) oxygen therapy and the Venturi mask at the 48-hour study steps. Medians are expressed as *horizontal bars* inside the *boxes*, 25th–75th percentiles as the bottom and the top of the *boxes*, and maximal-minimal values as *whiskers*. $^{*}P < 0.05$; $^{**}P \leq 0.01$.

Patient Discomfort

Adverse Events and Clinical Outcomes

	Control Group	NHF Group	*p* value
interface displacement	89	20	< 0.001
episodes of oxygen desaturation	178	40	< 0.001

Adverse Events and Clinical Outcomes

Table 2. Need for Ventilatory Support during the 48-Hour Study Period

	Control Group (*n* = 52)	NHF (*n* = 53)	*P* Value
Noninvasive ventilation, n (%)	8 (15.4)	2 (3.8)	0.042
Endotracheal intubation, n (%)	11 (21.2)	2 (3.8)	0.005
Cause of endotracheal intubation			
Hypercapnia with respiratory acidosis, n (%)	0	0	N/A
Changes in mental status, n (%)	1 (1.9)	1 (1.9)	0.989
Oxygen desaturation or hypoxia, n (%)	6 (11.5)	1 (1.9)	0.047
Unbearable dyspnea with respiratory muscle failure, n (%)	4 (7.7)	1 (1.9)	0.162
Persistent hypotension, n (%)	2 (3.8)	0	0.149
Inability to clear secretions, n (%)	6 (11.5)	1 (1.9)	0.047

Discussion

NHF results in better oxygenation for the same set FIO2

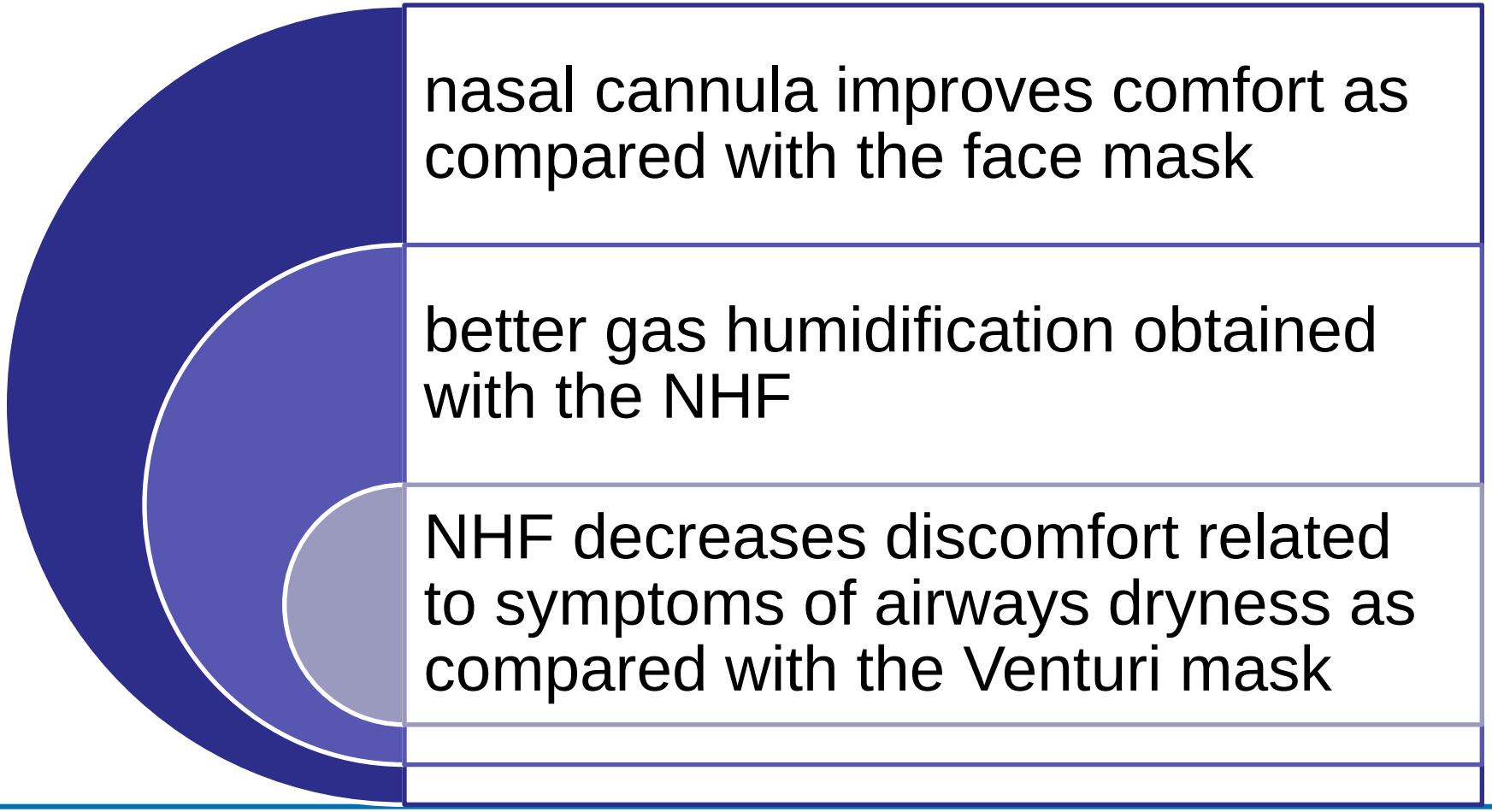
1. Providing a constant FIO2 by delivering the gas at flow rates that exceed the patient's peak inspiratory flow rate
2. the high gas flow can washout the upper airways deadspace and may create an oxygen reservoir within the upper airways
3. the high gas flow generates a positive airway pressure of 2–5 cm H2O, which is proportional to gas flow and may recruit the atelectatic lung

Effect of NHF on Other Respiratory Parameters

The contemporary decrease in the respiratory rate and in the PaCO2 suggests that deadspace was reduced with the NHF, may be explained by:

- increase in tidal volume
- improvement in inspiratory air-flow dynamics

Effect of NHF on Patient Comfort



Effect of NHF on Adverse Events and Weaning Outcome

- improved comfort with the NHF→less displacement of the interface
- better tolerance and the fewer interface dislodgements→reduced the episodes of oxygen desaturation with the NHF

Effect of NHF on Adverse Events and Weaning Outcome

improvement in oxygenation, comfort, and compliance with the therapy together with the improved patient ability to clear secretions

the use of the NHF in the postextubation period was associated with less need for NIV and fewer endotracheal intubations than the Venturi mask

Limitations

- masking of patients and personnel to treatment was not performed
- Not measure the true FIO2 delivered to patients and
- can not exclude that FIO2 was indeed greater with the NHF than with the Venturi mask
- assessment of patient discomfort was subjective
- all patients had an arterial blood gas collected at the end of the successful spontaneous breathing trial, immediately before extubation

Summary

1. As compared with Venturi mask, the use of NHF therapy resulted in better oxygenation for the same set FIO2.
2. discomfort related to the interface and to airways dryness improved, whereas the breathing frequency and the rate of interface displacement and of oxygen desaturation decreased.
3. Fewer patients in the NHF group required reintubation during the study period, suggesting a potential role of this device in protecting extubation

谢谢！