Effect of High-Flow Nasal Cannula versus Conventional Oxygen Therapy for Patients with Thoracoscopic Lobectomy after Extubation

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Background

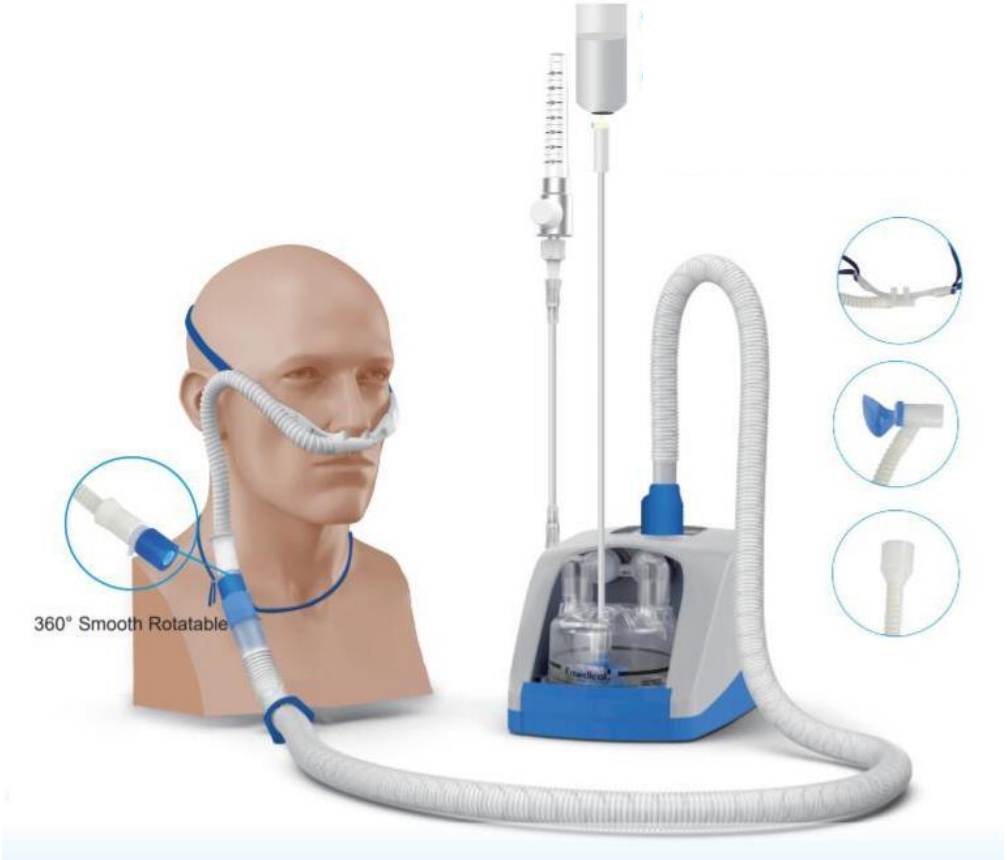
- Post extubation respiratory failure following major surgery is common, and a substantial proportion of the patients requires prolonged mechanical ventilation and prolonged intensive care unit (ICU) or hospital stay.

- Postoperative pulmonary complications (PPC) such as hypercapnia, atelectasis, and pneumonia which increase mortality are particularly attributable to adverse prognosis in patients with thorax surgery specially with lobectomy.

Background

- Respiratory support and oxygen therapy after tracheal extubation are of major importance to prevent hypoxemia and subsequent respiratory failure or reintubation in patients under general anaesthesia operation.

Background



- High-Flow nasal cannula oxygen (HFNC) mainly delivers a flow-dependent positive airway pressure and improves oxygenation by increasing end-expiratory lung volume, which can provide a maximum flow of 60L/min.

Background

- It is considered to have a number of physiological advantages compared with other standard oxygen therapies, including the provision of
  - Continuous positive airway pressure (CPAP)
  - Constant FiO_2
  - Good humidification
  - Reduce the anatomical dead space

Background

- Hypothesize

"HFNC treatment might be superior to conventional oxygen therapy in reducing the incidence of hypoxemia and PPC for patients with lobectomy after extubation."

Methods

- Trial Design
  - Prospective, unblinded, multicenter, randomized controlled trial
  - Approved by Board and Ethics Committee of Shanghai Jiaotong University School of Medicine
  - Informed consent from all participants

Methods : Population

- Inclusion criteria :
  - Patients who underwent planned thoracoscopic lobectomy because of lung tumor
  - Intermediate to high risk for postoperative pulmonary complications (PPC) (ARISCAT score ≥ 26)

Methods : Population

- Exclusion criteria :
  - Aged < 18 or > 80 years
  - Pregnancy
  - Immunocompromise
  - Converted to an open thoracotomy because of poor visualization or bleeding

Methods : Intervention

- The patients were ready for scheduled extubation after tolerating a spontaneous breathing trial in ICU.

- The decision to extubate was at the discretion of the treating doctors in ICU and no mandatory extubation variables were set.

Methods : Intervention

- Intervention group : HFNC oxygen therapy group (HFNCG)
  - A flow rate of 35 to 60 L/min and FiO_2 was titrated (from 45 to 100%) by the treating clinician to maintain a peripheral oxygen saturation (SpO_2) of 95 % or more
- Control group : conventional oxygen therapy group (COG)
  - Oxygen via either nasal prongs or facemask with oxygen flow titrated (from 45 to 100%) by the bedside clinician to maintain a SpO_2 of 95% or more.

Methods : Outcomes

- Primary outcome
  - Incidence of hypoxemia
    (Defined as PaO_2/FiO_2 of 300 mmHg or less) in the first 72 h after extubation

Methods : Outcomes

- Secondary outcomes
  - Differences of PaO_2, PaO_2/FiO_2, SaO_2/FiO_2, and $PaCO_2$
  - Rates of Postoperative pulmonary complication (PPC) like suspected pneumonia atelectasis
  - Adverse effects related to HFNC application and oxygen therapy (air leak, throat or nasal pain, and abdominal distension)
  - Arterial blood gas

Methods : Outcomes

- As the previous studies indicate that it was with high incidence of PPC within 72 h following thoracoscopic lobectomy.

- The arterial blood gases were consecutively collected and checked at 1, 2, 6, 12, 24, 48, and 72h after extubation.

Methods : Outcomes

- Acute hypoxemic respiratory define as
  - Severe respiratory distress with dyspnea, accessory muscle recruitment and paradoxical abdominal or thoracic motion
  - Respiratory rate > 25 breaths/min
  - Respiratory acidosis with pH < 7.30
  - Arterial carbon dioxide partial pressure ($PaCO_2$) > 50 mmHg

Methods : Outcomes

- Once a patient after extubation was found with acute hypoxemic respiratory failure, noninvasive ventilation (NIV) was adopted.

- If the symptoms of respiratory distress did not improve within 2 hours, then reintubation might be considered.

Statistical analysis

- Review of data from the three study centers over a 3 year period (2012 ~ 2014) revealed about 30 %of patients with hypoxemia who underwent thoracoscopic lobectomy after extubation.

- A sample size of 117 for each group provided 80 % power to detect a reduction in hypoxemia from 30% to 15% (alpha = 0.05).

- Statistical analysis was performed using SPSS version 19.0.

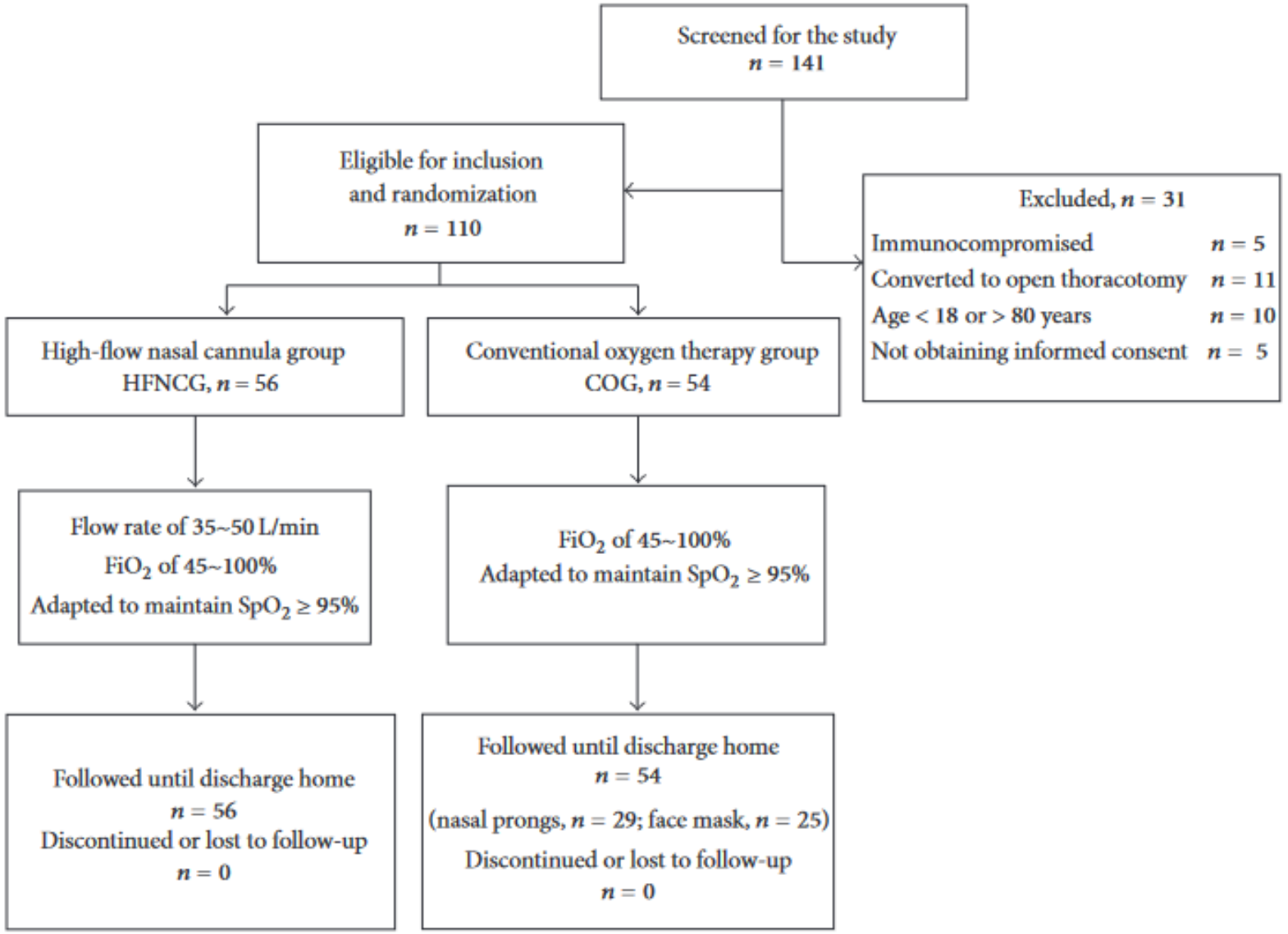


FIGURE 1: Flow chart of the study.

Table 1: Demographic characteristics of the patients who participated in the study (mean ± SD).

Characteristics	HFNCG ($n = 56$)	COG ($n = 54$)	P
Age, yrs	56.31 ± 7.03	55.82 ± 7.92	0.732
Male gender, n (%)	30 (53.57)	28 (51.85)	1.000
BMI, kg/m^2	26.32 ± 4.73	25.19 ± 5.02	0.226
APACHE II	26.32 ± 4.73	25.19 ± 5.02	0.226
ARISCAT	31.12 ± 3.74	32.36 ± 3.08	0.071
COPD, n (%)	8 (14.29)	7 (12.96)	0.840
Asthma, n (%)	5 (8.93)	4 (7.41)	1.000
Smoking history, n (%)	12 (21.43)	8 (14.81)	0.369
Hemoglobin, g/L	108.29 ± 17.31	105.43 ± 22.06	0.450
Lactate, mmol/L	0.32 ± 0.07	0.33 ± 0.06	0.424
Respiratory, /min	18.43 ± 3.45	17.98 ± 3.87	0.521
PaO_2, mmHg	95.37 ± 12.42	92.59 ± 18.49	0.355
$PaCO_2$, mmHg	41.73 ± 6.33	43.52 ± 4.93	0.102
PaO_2/FiO_2, mmHg	350.35 ± 33.87	340.98 ± 40.65	0.191
SaO_2/FiO_2	210.37 ± 52.77	222.51 ± 48.65	0.213
FRC, L	2.08 ± 0.32	2.12 ± 0.41	0.567
FEV1/FVC, %	78.63 ± 11.52	75.52 ± 13.45	0.195
Postsurgical ventilation durations, h	2.13 ± 0.43	2.18 ± 0.32	0.492

Table 2: Occurrence rates for outcomes in COG compared with HFNCG 72 h following extubation, *n* (%).

Characteristics	HFNCG ($n = 56$)	COG ($n = 54$)	P
Hypoxemia	7 (12.50)	16 (29.63)	0.027
Hypercapnia	3 (5.36)	8 (14.81)	0.121
Reintubation	0 (0)	5 (9.26)	0.026
Needing NIV	2 (3.57)	9 (16.67)	0.027
Atelectasis	2 (3.57)	5 (9.26)	0.266
Suspected pneumonia	2 (3.57)	2 (3.70)	1.000
Throat or nasal pain	1 (1.79)	7 (12.96)	0.030
Abdominal distension	3 (5.36)	0 (0)	0.243
Air leak	0 (0)	0 (0)	1.000

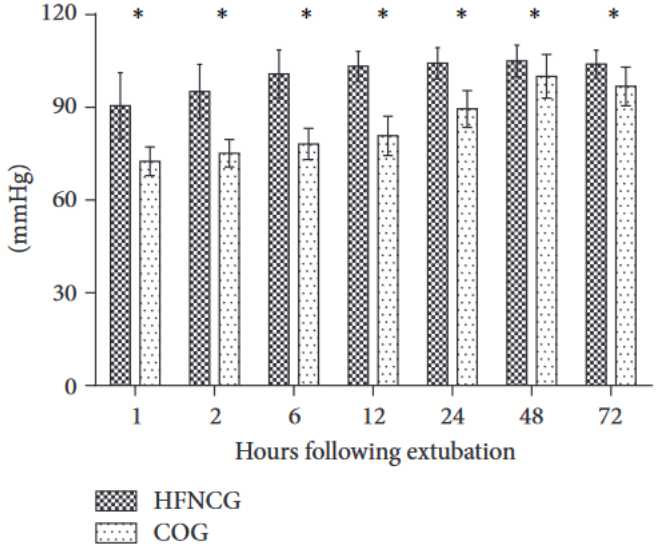
TABLE 4: Occurrence rates for outcomes in HFNC patients compared with COG patients with different oxygen concentrations 72 h following extubation, *n* (%).

Characteristics	HFNCG ($n = 56$)			P	COG ($n = 54$)			P
	FiO_2 (45~60%) ($n = 18$)	FiO_2 (60~80%) ($n = 22$)	FiO_2 (80~100%) ($n = 16$)		FiO_2 (45~60%) ($n = 17$)	FiO_2 (60~80%) ($n = 21$)	FiO_2 (80~100%) ($n = 16$)	
Hypoxemia	2 (11.11)	2 (9.09)	3 (18.75)	0.658	2 (11.76)	5 (23.81)	9 (56.25)	0.015
Hypercapnia	1 (5.56)	1 (4.55)	1 (6.25)	0.973	2 (11.76)	4 (19.05)	2 (12.50)	0.782
Reintubation	0 (0)	0 (0)	0 (0)	1.000	0 (0)	1 (4.76)	4 (25.00)	0.031
Needing NIV	0 (0)	0 (0)	2 (12.5)	0.075	0 (0)	3 (14.29)	6 (37.50)	0.014
Atelectasis	1 (5.56)	0 (0)	1 (6.25)	0.508	1 (5.88)	2 (9.52)	2 (12.50)	0.806
Suspected pneumonia	0 (0)	1 (4.55)	1 (6.25)	0.588	0 (0)	1 (4.76)	1 (6.25)	0.603
Throat or nasal pain	0 (0)	1 (4.55)	0 (0)	0.455	0 (0)	2 (9.52)	5 (31.25)	0.024
Abdominal distension	0 (0)	0 (0)	3 (18.75)	0.019	0 (0)	0 (0)	0 (0)	1.000
Air leak	0 (0)	0 (0)	0 (0)	1.000	0 (0)	0 (0)	0 (0)	1.000

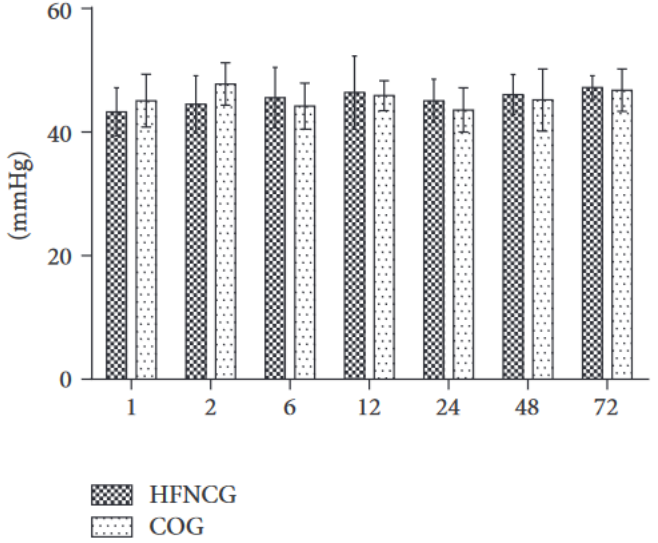
Table 5: Comparison of hospitalizations between two groups (mean ± SD).

Characteristics	HFNCG ($n = 56$)	COG ($n = 54$)	P
Mortality	0	0	1.000
Length of ICU stay, days	3.72 ± 0.56	3.64 ± 0.83	0.553
Length of hospital stay, days	7.41 ± 0.82	7.54 ± 0.91	0.433
Total hospitalization expenditures, $	11522.65 ± 762.45	12219.73 ± 1028.66	0.001

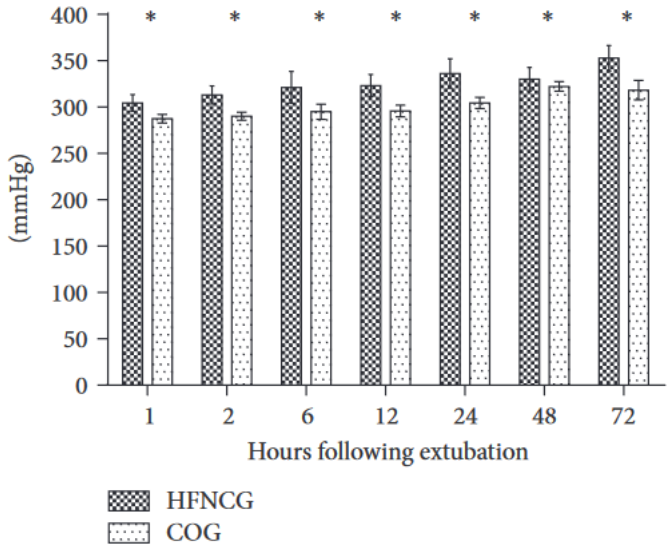
Arterial PaO2 values



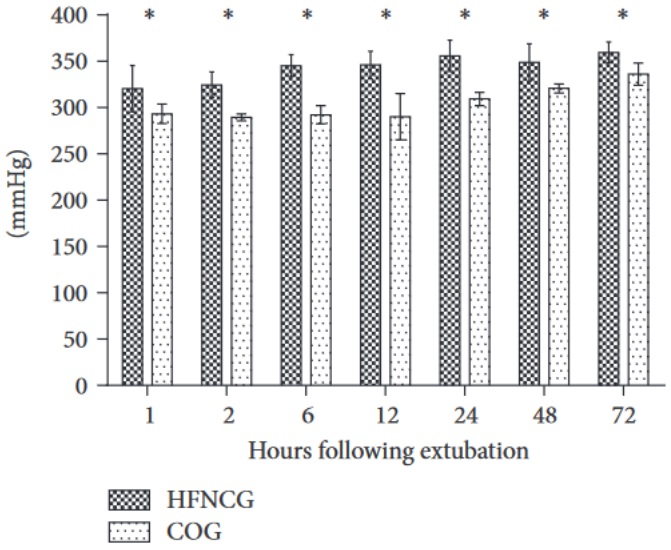
Arterial PaCO2 values



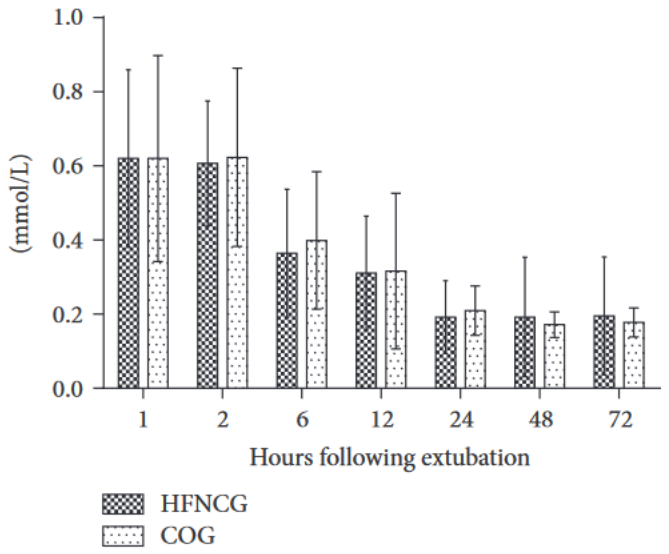
P/F ratio



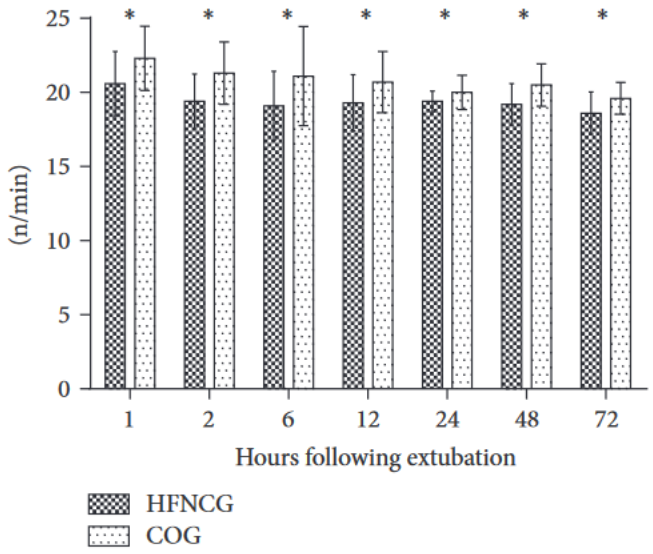
S/F ratio



Lactate values



Respiratory rate



Discussion

- The application of HFNC oxygen therapy in patients with thoracoscopic lobectomy after extubation could reduce the risk of hypoxemia and rate of NIV and reintubation ($P < 0.05$) as well as improve oxygenation represented by PaO_2, PaO_2/FiO_2 , and SaO_2/FiO_2 which reflected the advantage of HFNC.

Discussion

- HFNC has believed to deliver some level of
  - Continuous positive airway pressure (CPAP) via high-flow ventilation
  - Decreased airway resistance and flushed nasopharyngeal dead space, thereby contributing to the reduced work of breathing
  - Due to the provision of distending pressure and increase in end-expiratory lung volume. Considering the suspected induced effects of HFNC on lung volumes, we hypothesized that early initiation of HFNC could minimize in part lung derecruitment after extubation

Discussion

- While the mortality, length of ICU stay, length of hospital stay are not different between two groups.

- The total medical costs in COG were much higher. In our opinion, relatively more NIV and reintubation in COG may help to explain the increased medical costs.

Discussion

- Several studies have demonstrated that HFNC could accelerate the elimination of CO_2 and bronchial secretions which indicated that it might decrease the incidence of hypercapnia and pneumonia.

- Here was no difference in the incidence of hypercapnia and pneumonia between the groups in our study which was due to few patients with severe COPD or with muscle fatigue who were included in study period.

Discussion

- Dry or poorly humidified medical gas may elicit patient complaints, such as dry nose, dry throat, and nasal pain, and consequent poor tolerance of oxygen therapy. Better patient comfort, during high-flow nasal cannula than COG.

Limitation

- The sample size expected in each group was 117. The patients eligible were not as much as expected because the majority of patients with lobectomy were at low risk might lead to compromised statistical power to detect a significant difference between groups in the primary outcome.

- Extubation variables is not clearly state (Dependent on treating doctors).

- This research doesn’t state demographic data about operation (lung lobes).

Critical Appraisal

1. Were the following clearly stated:	Yes	Can't tell	No
• Patients	✓		
• Intervention	✓		
• Comparison Intervention	✓		
• Outcome(s)	✓		

Critical Appraisal

	Yes	Can't tell	No
2. Was the assignment of patients to treatments randomised?	✓		
3. Was the randomisation list concealed? Can you tell?			✓
4. Were all subjects who entered the trial accounted for at it's conclusion?	✓		
5. Were they analysed in the groups to which they were randomised, i.e. intention-to-treat analysis			✓

Critical Appraisal

	Yes	Can't tell	No
6. Were subjects and clinicians 'blind' to which treatment was being received, i.e. could they tell?			✓
7. Aside from the experimental treatment, were the groups treated equally?	✓		
8. Were the groups similar at the start of the trial?	✓		

Critical Appraisal

9. How large was the treatment effect? Consider • How were the results expressed (RRR, NNT, etc).	-
10. How precise were the results? Were the results presented with confidence intervals?	No

Critical Appraisal

	Yes	Can't tell	No
11. Do these results apply to my patient? • Is my patient so different from those in the trial that the results don't apply? • How great would the benefit of therapy be for my particular patient?	✓ ✓		
12. Are my patient's values and preferences satisfied by the intervention offered? • Do I have a clear assessment of my patient's values and preferences? • Are they met by this regimen and its potential consequences?			✓ ✓