Postoperative Non-Invasive Ventilation after Upper Abdominal Surgery in Chronic Obstructive Lung Disease

Gad Sayed Gad[a], Salah Mostafe Asida[a] , Asmaa Mohamed Mostafa[a*] , Mahmoud Mohamed Ahmed[a]

[a]Department of Anesthesia, ICU, and Pain Management, Faculty of Medicine, South Valley University, Qena, Egypt.

Abstract

Background: Chronic obstructive pulmonary disease (COPD) is a major risk factor for respiratory problems during extra-pulmonary surgery

Objectives: To investigate postoperative NIV in COPD patients following upper abdominal surgery to prevent pulmonary complications.

Patients and methods: In Qena University Hospital a prospective, randomized study was carried out on 100 COPD patients, all were divided into; conventional therapy without NIV (C group) 50 patients or with prophylactic NIV(N group) 50 patients.NIV applied for approximately 30 to 45 min at 2- to 4-h intervals for 48 h following surgery . Acute respiratory events ARE were the primary outcomes, while acute respiratory failure ARF, invasive ventilation, mortality rate, complications as pneumonia, NIV intolerance, and ICU stay were secondary outcomes.

Results: This study demonstrated a significant improvement in Spirometric and arterial blood gas values in N group. A total of 33 patients experienced ARE during the ICU days after surgery, 14 in N group and19 in C group ($p = 0.39$) . ARF occurred in 21 patients, including 9 in N group and 12 in C group ($p = 0.43$). five patients required invasive ventilation (3 in N group, 2 in C group). Postoperative pneumonia, atelectasis and ICU stay were similar between groups. NIV was applied as first-line rescue therapy in 6 patients N group, 10 patients in C group ($p = 0.05$). Heart disease comorbidity $p = 0.01$ and COPD with FEV1<60 % predicted $p = 0.03$ are significant risk factors with ARE.

Conclusion: Prophylactic NIV improved oxygenation and spirometry values, with no reduction in the rate of acute respiratory failure, invasive ventilation, mortality and ICU stay.

Keywords: Noninvasive ventilation; COPD; Abdominal surgery; Acute respiratory failure.

***Correspondence**: lalamohamed763@yahoo.com

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Introduction

One of the main risk factor for respiratory complications after extra-pulmonary surgery is chronic obstructive pulmonary disease (COPD) (**Gupta et al., 2013; Qaseem et al ., 2006; McAlister et al., 2003**).In COPD exposure to inhaled irritants such as smoking leads to chronic patients. Diaphragmatic dysfunction and a decrease in vital capacity usually followed the abdominal surgeries which lead to atelectasis and hypoxaemia. Postoperative diaphragmatic dysfunction leads to worsen respiratory impairment. Hypoxaemic events occur in 30 to 50% of patients undergoing abdominal surgeries, 8 to 10% require invasive ventilation postoperatively (**Squadrone et al .,2005**).

To optimize perioperative treatment options careful selection and screening of the risk patient, providing intraoperative protective ventilation and optimal postoperative respiratory monitoring and care **(Jaber et al., 2010)**.

The slandered treatment of postoperative respiratory failure has been invasive ventilation, which is associated with infectious and non infectious complications and increase morbidity and mortality (**Chiumello et al., 2011**).Non-invasive ventilation (NIV) has become slandered method in postoperative respiratory failure management(**Peñuelas et al., 2007).**

The advantages of NIV were improvement in the gas exchange, prevention of lung hyperinflation and reducing inspiratory load (**MacIntyre, 2019**).

This prospective randomized study aimed to compare between using prophylactic postoperative NIV in COPD patients after upper abdominal surgery to prevent postoperative pulmonary complications or not.

inflammation of the airways and lung tissue (**Vogelmeier et al.,2017**).

COPD is characterized by lung parenchyma destruction and small airway narrowing, which leading to ventilation-perfusion mismatching and impaired gas exchange (**Vogelmeier et al.,2017**) cause post-operative hypoxic events and respiratory failure in those

Patients and methods

A prospective, randomized study was carried out on 100 patients underwent elective upper abdominal surgery. Data were collected from January2019 to Mars 2020 and patients were assigned to the groups by a random number generator. The two groups were divided according to whether conventional postoperative treatment without NIV (groupC) 50 patients or with prophylactic NIV (group N) 50 patients.

Inclusion criteria

1- Age>18 years.
2- Scheduled for upper abdominal surgery under general anesthesia.
3- COPD, GOLD classification II to IV (moderate to very severe) (**Vogelmeier et al., 2017).**
4- ASA functional status II or greater.

Exclusion criteria

1-Contraindications to the application of NIV absolute or relative (**Bauchmuller and Glossop, 2016**), (severe agitation, copious secretions, uncontrolled vomiting).
2- Sleep apnea syndrome.
3- Facial deformation.
4- Refused to conduct in the research.

All the patients having been informed both verbally and in written consent to allocate in the research the day before surgery. The study was registered with Clinical Trials.gov Identifier: NCT04877353

Preoperative period

During the preoperative period all patients received bronchodilators

nebulization therapy and early chest Physiotherapy to promote bronchial drainage. Antimicrobial prophylaxis (penicillin or cephalosporin) was administered routinely according to patients' condition.

Intraoperative period

Standard anaesthesia techniques were used in all .All patients were operated on by selective endotracheal intubation mechanically ventilated with volume controlled mechanical ventilation using (Datex Ohmeda A 7100 GE Healthcare, Finland)as the following parameters tidal volume 8 ml/kg, RR 12b/min, the anesthetics administered were propofol 1% 2mg/kg ,nalbuphine0.2mg/kg and cisatracurium0.15mg/kg. Anesthesia was maintained by isoflurane in oxygen (FiO_2 = 0.1) during the whole anesthesia period.

The hemodynamic parameters electrocardiogram, heart rate (HR), non-invasive blood pressure and pulse oximetry (SaO_2) and respiratory parameters: respiratory rate (RR), FiO_2, end tidal CO2 ($ETCO_2$), tidal volume, minute volume and peak inspiratory pressure were continuously monitored (GE Healthcare USA).

After induction, the radial artery was accessed to measure invasive blood pressure and to analyze blood gasses.

A central vein right or left jagular was also cannulated. When the operation was done, after reversal of neuromuscular block and extubation, the patients were admitted postoperative to the Critical Care Unit.

All patients were monitored, and the conventional group (group C) Venturi facemask FiO_2 <40% was applied. (FiO_2 was set to achieve SaO_2 ≥92%).

NIV group (group N) initial prophylactic settings were the following: an inspiratory positive airway pressure IPAP/expiratory positive airway pressure EPAP of 8 cm H_2O /4 cm H_2O. Initial settings could be modified if necessary. FiO_2 was set to achieve SaO_2 ≥92%. Prophylactic NIV applied for 30 to 45 minutes at 2- to 4-hours intervals for 48 h following surgery. (See supplementary material)

Visual analogy scale VAS was used to assess postoperative pain, patients received multimodal analgesia with analgesic free opiates drugs as(paracetamol 1 gm per dose/8hs) or spinal analgesia (intrathecal or epidural with local anesthetics (bupivacaine 15 mg 0.5% bupivacaine 0.1% 1.5-2mg/kg respectively).

The primary outcomes

The rate of acute respiratory events ARE during the days of ICU stay after surgery, ARE was defined by at least two of the following criteria: PaO_2/FiO_2<200mmHg, $PaCO_2$ increase of more than 10 mmHg above baseline postoperative value, respiratory rate >30/min or a new pulmonary infiltrate on chest X-ray **(Lorut et al., 2014).**

Secondary outcomes

Those were acute respiratory failure ARF, invasive ventilation, mortality rate, infectious and non-infectious complications, and length of ICU stay. (See supplementary material).

Data Collection

A) Data collected prior to anesthesia induction

Demographic characteristics of the patient: age and sex, body mass index BMI, ASA American Society of Anesthesiology (anesthesia risk scale), smoking status, Patients comorbidities and baseline spirometry (VYAIRE'S MICROLAB):FEV1%, FEV1/FVC and FEV1< % predicted , room air arterial blood gas: pH, PaO_2, $PaCO_2$.

B) Data collected intraoperative

Hemodynamic parameters: non-invasive arterial blood pressure, spO_2, $ETCO_2$ and HR, type of surgery, duration of anesthesia, total fluid

volume infusion , red blood transfusion.

C) Data collected postoperative

In the immediate postoperative period; Pain measurement (visual analogue scale –VAS),type of analgesia, blood pressure, HR, RR, $SpO_2$and, blood count, coagulation tests , biochemical (creatinine, urea, sodium, potassium), arterial blood gases.

- Data collected at 1st day postoperatively: Simplified Acute Physiology Score SAPS II score, arterial blood gases (pH, $PaCO_2$, PaO_2), spirometry (FEV1%, FEV1/FVC and FEV1< % predicted).
- Data collected at 3nd day postoperatively: arterial blood gases, spirometry (FEV1%, FEV1/FVC and FEV1< % predicted).

Statistical analysis

The sample size was composed of 100 patients allocated into two group, each group consisted of 50 patients. They constituted the total of consecutive COPD patients, candidates for the upper abdominal surgery and who met the criteria for inclusion in a period of 14 months**.** Calculations indicated a minimum sample size of 100 patients [confidence level (1 - a) 90 %, power level (1 - b) 80 %].

SPSS 21 statistical software (IBM, USA) was employed. All variables are reported as mean and standard deviation SD or percentages as appropriate. ARE, vital status and other endpoints were compared between the two groups (conventional and prophylactic NIV) using the Chi square test or the Fisher exact test, as appropriate. Cox proportional hazards analysis was used to evaluate the effect of the covariates on postoperative ARE. Relative risks and their 95 % confidence interval (CI 95 %) were calculated. The comparison between groups was performed using statistical x^2-test.The accepted level of significance was p value <0.05.

Results

On 100 patients COPD patients undergoing upper abdominal surgery under general anesthesia, Patients allocated into; group C: consisted of 50 patients received conventional postoperative treatment (venturi O_2 facemask) without NIV, group N:consisted of 50 patients received prophylactic NIV.The baseline characteristics all are listed in (**Table.1)** and there is no significant difference between the two group regarding age ,body mass index, gender ,smoking status ,ASA classification, patients comorbidities ,type of surgery, duration of anesthesia, total infused intraoperative fluids, volume of blood transfused , severity of illness evaluated by simplified acute physiologic score SAPS at ICU admission, pain management and evaluation of visual analogue score.

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Table 1. Baseline characteristics of patients

Variables	Group N (n=50)	Group C(n=50)	P value
Age(years)	59.86±6.81	61.54±7.46	0.209
BMI(kg/m^2)	27.52±3.55	27.82±4.52	0.673
Gender(male/female)	80%(40)/20%(10)	82%(41)/18%(9)	0.791
ASA			0.181

II	8%(4)	16%(8)		
III	56%(28)	74%(37)		
IV	36%(18)	30%(15)		
Smoking status			0.836	
yes	36%(18)	32%(16)		
No	64%(32)	68%(34)		
Patients comorbidities			0.781	
Cardiovascular	34%(17)	28%(14)		
Chronic renal diseases	8%(4)	14%(7)		
DM	10%(5)	10%(5)		
Neoplasia	12%(6)	6%(3)		
Type of surgery			0.301	
Hepato-pancreato-biliary (HPB)	46%(23)	42%(21)		
Gastrectomy	26%(13)	34%(17)		
colectomy	22%(11)	16%(8)		
Others surgery	6%(3)	8%(4)		
Duration of surgical intervention(hours)	3.56±1.25	3.74±1.12	0.625	
Fluid infusion volume(L)	2115±1454	2311±1284	0.107	
Red Blood cell transfusion	12%(6)	14%(7)	0.761	
Type of analgesia			0.711	
Epidural catheter	18%(9)	20%(10)		
Intrathecal analgesia(isobaric bupivacaine 0.5%)	3%(2)	8%(4)		
SAPSII at ICU admission	30.4±8.4	29.7±9.1	0.171	
Pain level evaluationVAS <4			0.431	
Day 1	58%(29)	54%(27)		
Day 2	68%(34)	62%(31)		
Day 3	74%(37)	76%(38)		

Data presented as: mean ± standard deviation or number (n) Percentages %. *p value significant <0.05. BMI body mass index, ASA American Society of Anesthesiologists, DM Diabetes mellitus, SAPS, Simplified Acute Physiologic score,VAS visual analogue scale.

The results of spirometric values are shown in (**Table.2),** there is no statistically significant difference in the preoperative value (obstructive air flow pattern) and the first day after the using of prophylactic NIV compared the two group of study, in the 3rd day of ICU admission there is a significant improvement in Spirometric values in the N group (FEV1%

58.78±5.33,FEV1/FVC57.38±4.55, FEV1 predicted 67.43±6.23) p value <0.001. Blood gas values measured in room air are shown in (**Table.3)**, the preoperative and immediate postoperative(before NIV initiation) values between there is no statistically significant between the two groups , regarding to the 1st day and 3rd day postoperative and as compared to the controlled group ,the application of NIV significantly improved the all parameters of the arterial blood gas values measured on room air pH, arterial oxygen tension (PaO_2)carbon dioxide tension ($PaCO_2$) (p= 0.01)1st day , pH (p=0.04), arterial oxygen tension (PaO_2)(p=0.01)carbon dioxide tension ($PaCO_2$) (p= 0.16)3rd day.

Table2 . Spirometric values

Variables	Group N(n=50)	Group C(n=50)	P value
Preoperative values			
FEV1 (%), mean ± SD	61.26±6.40	62.96±5.41	0.19
FEV1/FVC (%), mean ± SD	58.52±6.42	57.74±5.7	0.52
FEV1% pred	71.93±6.7	70.87±7.13	0.21
Day 1 postoperative			
FEV1 (%), mean ± SD	51.32±6.97	49.36±9.1	0.22
FEV1/FVC (%), mean ± SD	55.32±4.6	53.41±4.3	0.13
FEV1 % pred,	62.34±7.64	51.76±4.6	0.07
Day 3 postoperative			
FEV1 (%), mean ± SD	58.78±5.33	52.88±7.33	0.001*
FEV1/FVC (%), mean ± SD	57.38±4.55	54.32±4.39	0.001*
FEV1% pred	67.43±6.23	51.96±4.8	0.001*

FEV1 forced expiratory volume in one second. FVC forced vital capacity. * Highly Significant P value 0.001.

Table 3. Arterial blood gas values

Variables	Group N(n=50)	Group C(n=50)	P value
Preoperative			
PH	7.40±0.4	7.41±0.5	0.81
Pao_2 mmHg	73±2	75±2	0.74
$Paco_2$ mmHg	41±4	40±4	0.53
immediate postoperative			
PH	7.33±3.6	7.32±4.6	0.36
Pao_2 mmHg	59±4	56±5	0.64
$Paco_2$ mmHg	46±4	44±5	0.82
Day 1 postoperative			
PH	7.40±4.3	7.36±2.9	0.01*
Pao_2 mmHg	72±3	58±6	0.01*
$Paco_2$ mmHg	39±2	42±5	0.01*

Day 3 postoperative			
PH	7.42±3.1	7.38±4.1	0.04*
Pao_2 mmHg	71±5	60±6	0.01*
$Paco_2$ mmHg	40±3	42±4	0.16

Note that room air arterial blood gases were performed in both group and after NIV sessions in the NIV group. Data are mean ±SD.
* Significant P value<0.05.

Table 4. Patients' outcomes

Variables	Group N(n=50)	Group C(n=50)	P value
ARE	28%(14)	38%(19)	0.39
Acute respiratory failure	18%(9)	24%(12)	0.43
IMV	6%(3)	5%(2)	0.18
Pneumonia	8%(4)	8%(4)	1
Atelectasis	8%(4)	10%(5)	0.73
Length of ICU stay	6.54±2.4	6.76±2.5	0.65
Mortality	4%(2)	6%(3)	0.52

Data are presented as %(n). *significant p < 0.05. ARE acute respiratory event, IMV invasive mechanical.

ARE presented in 33 patients during the ICU days after surgery, 14 in NIV group (28 %) and19 (38 %) in the conventional group (p = 0.39) (Table 4). 21 patients experienced ARF (21 %), including 9 (18 %) in NIV group and 12 (24 %) in the conventional group (p = 0.43). five patients indicated immediate invasive ventilation at the time ARF occurred (3 in the NIV group, 2 in the conventional group). Postoperative pneumonia, atelectasis and length of ICU stay did not differ between groups with total mortality rate was 10 % (6 % in the conventional group vs. 4 % in NIV group; p = 0.52), (**Table. 4).**

In 16 patients , NIV was used as first-line rescue therapy,6 were in NIV group and 10 in the conventional group (p = 0.05).NIV used as rescue therapy to prevent reintubation in 12/16 (75 %), with no difference between groups: 4/6 patients (66 %) in NIV group and 8/10 patients (80 %) in the conventional group (p = 0.31). 5 patients intubated and invasive ventilated in NIV group and 4 in the conventional group, 3 in each group were intubated for surgical complications, i.e. 1 post-operative intraperitoneal bleeding and 2 sever sepsis in NIV group, and 1 intraperitoneal bleeding, 1 sever sepsis and 1 cerebrovascular accident in the conventional group,(**Fig.1)**

Infectious complications were observed in 10 patients in NIV group compared to 6 patients with non infectious complications **(Table. 5)**
There is no significant difference in the two groups of study regarding the events used to define ARE. (Table 1 See supplementary material) In univariate analyses were heart disease comorbidity as (abnormal heart rhythm, coronary heart disease) [HR=0.13(0.04-0.40); p=0.01] and COPD with FEV1<60 % predicted as a cut point [HR = 1.40(1.04-2.02); p = 0.03] are significant risk factors associated with ARE in both groups. **(Table.2 , See supplementary material**).

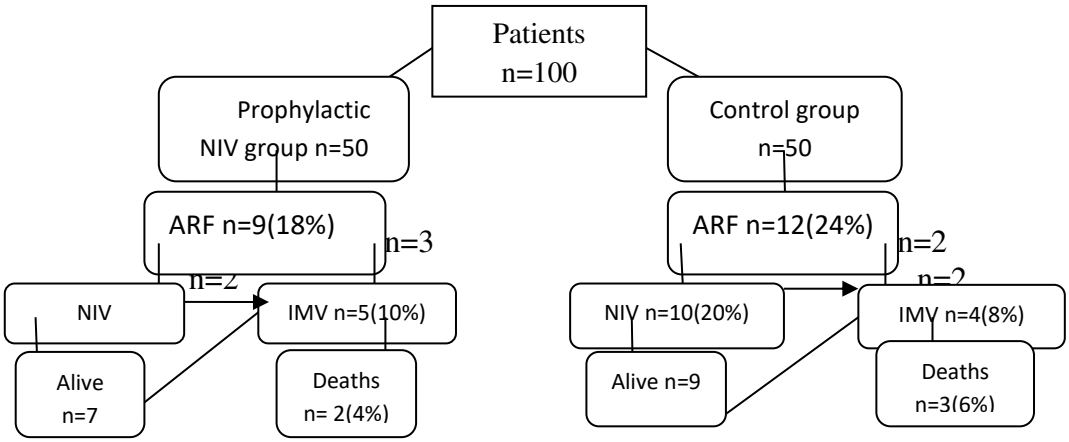

Fig.1 Management of acute respiratory failure.

IMV;invasive mechanical ventilation, NIV; non-invasive ventilation.

Table 5. Complications occurred in NIV group.

Complications	N(%)
Total	16(32%)
Infectious complications	10 (20%)
Pneumonia	4 (8%)
Lower respiratory tract infection	3 (6%)
Severe sepsis with other sources	3(6%)
Non infectious complications :	6 (12%)
Gastric distension	2 (4%)
ACPO	1 (2%)
NIV intolerance	3 (6%)
Skin ulceration	0

Data are n(%). ACPO, Acute colonic pseudo obstruction.

Discussion

We analyzed the differences between either using (group N) or not using (group C) prophylactic NIV on COPD patients after upper abdominal surgery. In our study examination of the results of spirometry after surgery showed decline FEV1%,FEV1 %predicted and FEVI/FVC% day 1 postoperative in both groups which improved significantly in the third day(p value <0.001) postoperative in the NIV group.

As for the values of blood gases in NIV group, both the first and the third day, the $PaCO_2$ remained similar to preoperative values. In the conventional group, PaO_2 was lower than the preoperative values, also increasing on the third postoperative day. As for the $PaCO_2$, it increased

immediately after surgery and the first postoperative day and then decreased, but both the paO_2 and $pacO_2$ significantly improved in NIV group compared to conventional group.

Conversely to our study, Guerra et al. reported in a clinical randomized trial of 50 patients who presented for thoracotomy lung resection, patients randomized to one of two groups ,group received conventional oxygen therapy and group received prophylactic BiPAP for 17 hours postoperative, blood gas and Spirometric results didn`t show significant value in both groups. **(Guerra et al., 2018).** This is probably due to a higher number of treatment hours (48 hours postoperative in our study), and because the patients had worse spirometry data as our COPD patients.

Consistent to our results, YAĞLIOĞLU et al. investigated the effect of two different modes of NIV; continuous positive airway pressure CPAP and bilevel positive airway pressure BIPAP and oxygen support. Eighty patients with chronic COPD underwent elective abdominal surgery with laporotomy, they found that application of prophylactic respiratory ventilation can prevent postoperative decline in pulmonary functions **(YAĞLIOĞLU et al., 2015).**

In our study prophylactics NIV did not decrease in the rate of ARE and ARF (18% in NIV, 24% conventional group) in COPD patients, although it decreases the rate of ARF requiring rescue non-invasive ventilatory support (12% in NIV,20% IN conventional group). Similar to our study **a** multisite prospective randomized clinical trial examined the use of postoperative prophylactic NIV following pneumonectomy 360 in COPD patients , standard oxygen therapy was compared with scheduled intermittent NIV for 48 hours postoperative, it didn`t find significant difference in the primary outcomes between the two groups regarding ARE, with secondary outcomes showing a decreased rate of ARF in the study group, but no difference in rates of reintubation, infections, or mortality **(Lorut et al., 2014).**

In the present study, intubation and invasive mechanical ventilation were similar between groups and rather lower in conventional group(6% in NIV group, 5% Conventional group). Postoperative NIV could be a good optional therapy for Patients with COPD . Patients with COPD showed more improvement in oxygenation on Postoperative day 1 than those without COPD (**Chiumello et al.,2011).**

Using NIV postoperative did not prevent all postoperative respiratory complications in COPD patients, such as pneumonia. However, in a study by OKADA et al. reviewed 143 patients underwent pulmonary lobectomy. NIV was used immediately after surgery until the morning of day one postoperative, the rate of pneumonia was 1.8% with no severe respiratory failure or 30-day mortality in the interventional group**(OKADAetal., 2018).**

Conversely to our results due to different type of surgery, a previous reported study postoperative cardiac surgery 32 patients were randomly allocated into two groups: control (18 patients) and intervention (14patients) which received NIV/pressure support ventialtion mode during 2hours postextubation, nine patients from the control group had ARF compared to no ARF presentation in interventional group **(Aquim EE ,2010).**

Our study population was the moderate to very severe COPD patients according to the GOLD classification of severity of airflow

obstruction, in our study very severe and severe COPD patients were small numbers.67% of the patients had moderate preoperative airflow obstruction (FEV1>60 % predicted value). In univariate analysis we found there was a significant interaction between COPD severity and occurrence of ARE [HR 1.40 (1.04–2.02), p = 0.03]. In the present study to increase the NIV efficacy we applied it immediately after extubation, as the mean time between extubation and NIV initiation was less than 4 hours.

Consistent to our findings, Zoremba et al. in a randomized study found that early initiation of NIV in postoperative care unit provides more improvement of postoperative pulmonary function (measured by inspiratory and expiratory spirometry, four times during the first 24 hour) and oxygenation in obese patients **(Zoremba et al., 2011).**

In our study the intermittent application of NIV, 30-45 min at 2-4hs interval for two days, may be inadequately effective in preventing postoperative pulmonary complications. Kindgen-Milles et al. reported better outcomes with continuous application of NIV (**Kindgen-Milles et al., 2005).**

In this study Prophylactic NIV does not affect the rate of pneumonia, mortality rate, and length of ICU stay. Consistent to our findings other studies reported that postoperative NIV didn`t decrease incidence of postoperative respiratory complication, it should be considered that there were different circumstances in different studies, such as the type of surgery (**liao et al.,2010; perrin et al., 2007; pasquina et al., 2004**).

Patients who required NIV for < 48 hours had no complications related to NIV use **(Kindgen-Milles et al., 2005).**These results are not comparable to those observed in our study as only two patients complicated with gastric distension(13 patient who underwent Gastrectomy operation,11 colectomy) ,one patients with acute pseudocolonic distension and 3 patients with NIV intolerance.

Initial prophylactic NIV settings may be inefficient in some cases. In our study, since we were applying preventive NIV to patients without respiratory failure, the initial inspiratory pressure was set at 8 cm of H2O, i.e. only 4 cm of H2O above PEEP level. This initial setting was chosen to avoid harmful effects of high pressure or high volume ventilation (**Jeon K et al., 2009).**

In our study we were trying to avoid gastric distension by insertion of nasogastric tubes before NIV institution and we regularly decompress the stomach. To avoid tolerance of NIV higher ventilatory pressures were not preferred as they are associated with desynchronization between the patient's spontaneous breathing, gastric distension and air leak around the face mask (**Brochard et al.,2000).**

Conclusion

We investigated the using prophylactic NIV on COPD patients after upper abdominal surgery, in this study Prophylactic NIV use improved the arterial oxygenation and spirometry values compared to conventional oxygen therapy. In our study, prophylactic NIV didn`t decrease the rate of ARF, with no difference regarding intubation rates in the two groups. Postoperative prophylactic NIV does not decrease the rate of postoperative respiratory

complications, mortality rate, and length of ICU stay.

References

- **Aquim EE.(2010).** Noninvasive mechanical ventilation in immediate postoperative cardiac surgery patients. Rev Bras Ter Intensiva, 22(4):363-368.
- **Bauchmuller K, Glossop AJ.(2016).** Non-invasive ventilation in the perioperative period. Bja Education, 16(9):299-304.
- **Brochard L.(2000).** What is really important to make noninvasive ventilation work. Critical care medicine, 28(6):2139-2140.
- **Chiumello D, Chevallard G, Gregoretti C.(2011).** Non-invasive ventilation in postoperative patients: a systematic review. Intensive care medicine, 37(6):918-929.
- **Guerra Hernández E, Rodríguez Pérez AE, Freixinet Gilard J, Álamo M, Escudero Socorro M, Rodríguez Suárez P,et al .(2018).** Prophylactic use of non-invasive mechanical ventilation in lung resection. European review for medical and pharmacological sciences, 22: 190-198.
- **Gupta H, Ramanan B, Gupta PK, Fang X, Polich A, Modrykamien A,et al. (2013).** Impact of COPD on postoperative outcomes: results from a national database. Diseases of the Chest, 143(6):1599-1606.
- **Jaber S, Chanques G, Jung B, Riou B.(2010).** Postoperative noninvasive ventilation. The Journal of the American Society of Anesthesiologists, 112(2):453-461.
- **Jeon K, Yoon JW, Suh GY, Kim J, Kim K, Yang M, et al .(2009).** Risk factors for post-pneumonectomy acute lung injury/acute respiratory distress syndrome in primary lung cancer patients. Anaesthesia and intensive care, 37(1):14-19.
- **Kindgen-Milles D, Müller E, Buhl R, Böhner H, Ritter D, Sandmann W,et al (2005).** Nasal-continuous positive airway pressure reduces pulmonary morbidity and length of hospital stay following thoracoabdominal aortic surgery. Diseases of the Chest, 128(2):821-828.
- **Liao G, Chen R, He J.(2010).** Prophylactic use of noninvasive positive pressure ventilation in post-thoracic surgery patients: a prospective randomized control study. Journal of thoracic disease, 2(4):205-209.
- **Lorut C, Lefebvre A, Planquette B, Quinquis L, Clavier H, Santelmo N,et al .(2014).** Early postoperative prophylactic noninvasive ventilation after major lung resection in COPD patients: a randomized controlled trial. Intensive care medicine, 40(2):220-227.
- **MacIntyre NR.(2019).** Physiologic effects of noninvasive ventilation. Respiratory care, (6):617-628.
- **McAlister FA, Khan NA, Straus SE, Papaioakim M, Fisher BW, Majumdar SR, et al .(2003).** Accuracy of the preoperative assessment in predicting pulmonary risk after nonthoracic surgery. American journal of respiratory and critical care medicine, 167(5):741-744.
- **Okada S, Ito K, Shimada J, Kato D, Shimomura M, Tsunezuka H, et al .(2018).** Clinical application of postoperative non-invasive positive pressure ventilation after lung cancer surgery. General

thoracic and cardiovascular surgery, 66(10):565-572.

- **Pasquina P, Merlani P, Granier JM, Ricou B.(2004).** Continuous positive airway pressure versus noninvasive pressure support ventilation to treat atelectasis after cardiac surgery. Anesthesia & Analgesia, 99(4):1001-1008.
- **Peñuelas O, Frutos-Vivar F, Esteban A.(2007).** Noninvasive positive-pressure ventilation in acute respiratory failure. Canadian medical association journal, 177 (10):1211-1218.
- **Perrin C, Jullien V, Vénissac N, Berthier F, Padovani B, Guillot F,et al .(2007).** Prophylactic use of noninvasive ventilation in patients undergoing lung resectional surgery. Respiratory medicine,101(7):1572-1578.
- **Qaseem A, Snow V, Fitterman N, Hornbake ER, Lawrence VA, Smetana GW,et al .(2006).** Risk assessment for and strategies to reduce perioperative pulmonary complications for patients undergoing noncardiothoracic surgery: a guideline from the American College of Physicians. Annals of internal medicine,144(8):575-580.
- **Squadrone V, Coha M, Cerutti E, Schellino MM, Biolino P, Occella P,et al .(2005).** Continuous positive airway pressure for treatment of postoperative hypoxemia: a randomized controlled trial. The Journal of the American Medical Association, 293 (5):589-595.
- **Vogelmeier CF, Criner GJ, Martinez FJ, Anzueto A, Barnes PJ, Bourbeau J,et al.(2017).** Global strategy for the diagnosis, management, and prevention of chronic obstructive lung disease 2017 report. GOLD executive summary. American journal of respiratory and critical care medicine, 195(5):557-582.
- **Yağlıoğlu H, Köksal GM, Erbabacan E, Ekici B.(2015).** Comparison and evaluation of the effects of administration of postoperative non-invasive mechanical ventilation methods (CPAP and BiPAP) on respiratory mechanics and gas exchange in patients undergoing abdominal surgery. Turkish journal of anaesthesiology and reanimation,43(4):246-252
- **Zoremba M, Kalmus G, Begemann D, Eberhart L, Zoremba N, Wulf H, et al .(2011).** Short term non-invasive ventilation post-surgery improves arterial blood-gases in obese subjects compared to supplemental oxygen delivery-a randomized controlled trial.BMC anaesthesiology, 11(1):1-8