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Clinical Research

STUDY OF EFFECTIVENESS OF NON INVASIVE VENTILATION IN ACUTE RESPIRATORY INSUFFICIENCY IN COPD PATIENTS.

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ABSTRACT Acute respiratory insufficiency due to chronic obstructive pulmonary disease (COPD) presents an enormously increasing problem in health sector[1] The choice of treatment of chronic respiratory failure in COPD patients depends primarily on which part of the respiratory system is impaired. pulmonary failure with the hallmark of hypoxaemia is a well-justified . In contrast, respiratory failure coupled with reduced alveolar ventilation requires artificial augmentation of alveolar ventilation.. Mechanical ventilation is often applied in the late stages of COPD or in patients with rapid clinical deterioration[3] . Applying the standard invasive mechanical ventilation (IMV) means confronting the patient with all the side effects and complications following endotracheal intubation [3]

These complications include: damage to the trachea caused by endotracheal tube producing ulceration, oedema and haemorrhage that can lead to tracheal stenosis [4]. There are also potential complications of this MV method eg damage to the face and nose skin, gastric distension with aspiration risk, sleeping disorders and conjuctivitis[5] Noninvasive mechanical ventilation (NIMV) presents an alternative to conventional IMV through an endotracheal tube, both in early stage of ARF as well as in patients with severe diseases[6,7]. It includes similar techniques for alveolar ventilation improvement to those of IMV, but without endotracheal intubation[8]

It permits a higher inspired oxygen content than other methods of oxygen supplementation, increases mean airway pressure, and will improve ventilation to collapsed areas of the lung. The recruitment of underventilated lung is similar to the use of positive end expiratory pressure (PEEP) in the intubated mechanically ventilated patient. It also unloads the inspiratory muscles and thereby reduces inspiratory work, although in hyperinflated patients with airflow obstruction any further increase in lung volume produced by it may have an adverse effect on the function of the inspiratory muscles. In cases of respiratory failure due to exacerbations of COPD, the offsetting of intrinsic PEEP may reduce ventilatory work resulting in a slowing of respiratory rate, an increase in alveolar ventilation, and a fall in PaCO2.Hence a retrospective analysis was done to study the efficacy of NIV in acute exacerrrbation of COPD patients .

MATERIAL AND METHODS: A retrospective analysis was done to ascertain the effect of early NIV on the respiratory improvement of patient in acute respiratory insufficiency .As per the guidelines laid down by the thorasic society[2002 GUIDELINES]] and as per the institutional protocol NIV was used as a therapeutic modality..The effect was stastistically analysed .40 patients of COPD were studied retrospectively.Out of them Group A comprises of 20 patients who were ventilated with NIV (Bipap) and othe Group B comprises of 20 patients who were not been given appropriate NIV for required stipulated time due to various factors .Although group B candidates fulfill the criteria for NIV but the patients were either extremely uncooperative , highly apprehensive about the NIV system ,unable to purchase appropriate sized mask .This caused inappropriate use of NIV in proper stipulated time required in group B patients

Observations: It was observed that there was significant improvement in respiratory parameters when NIV was used early .Minute ventilation as well as respiratory acisosis improved significantly .Moreover patient was able to take calories orally,was able to sleep n could interact with the health care providers. Need of invasive ventilation was prevented and thereby its complications .Since initial improvement encourages the patients for further cooperation and creates vicious cycle of positive events.

Conclusion: NIV proves to be an effective modality for acute respiratory insufficiency in COPD patients.Its recommended to start NIV support early to obtain better clinical outcome.

KEYWORDS :

INTRODUCTION :

Acute respiratory insufficiency due to chronic obstructive pulmonary disease (COPD) presents an enormously increasing problem in health sector[1] . COPD is defined as a disease state characterized by airflow limitation that isn't fully reversible. The airflow limitation is usually both progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases[2] The respiratory system consists of two independent parts : the lungs, which are responsible for gas exchange; and the respiratory pump, which regulates mechanical movements to ventilate the lungs.

Any pathology of the lungs causes pulmonary failure leading to hypoxaemic respiratory failure. This indicates that gas exchange is impaired, with oxygen being primarily affected because of its poorer diffusion capacities compared with carbon dioxide. In this scenario, hypoxaemia, but not hypercapnia, is present on blood gas analysis. Pulmonary failure may even be accompanied by hypocapnia resulting from an increased demand of ventilation aimed at compensating for hypoxaemia.

This contrasts with ventilatory failure that primarily leads to hypercapnia in addition to hypoxaemia as a result of reduced alveolar ventilation. Ventilatory failure indicates failing of the respiratory pump and is most often the result of either an increased load being imposed on the respiratory muscles, or a decreased capacity of the respiratory muscles, or both, but it can also result from disturbances in respiratory drive . Acute development of ventilatory failure results in respiratory acidosis following increasing arterial carbon dioxide tension ($P_{a,CO2}$). when hypercapnia, ensues, ventilatory failure occurs

Treatment of chronic respiratory failure in COPD patients

The choice of treatment of chronic respiratory failure in COPD patients depends primarily on which part of the respiratory system is impaired. pulmonary failure with the hallmark of hypoxaemia is a well-justified basis for long-term oxygen treatment (LTOT), with well-documented improvements in long-term survival in COPD patients . In contrast, respiratory failure coupled with reduced alveolar ventilation requires artificial augmentation of alveolar ventilation . Mechanical ventilation is often applied in the late stages of COPD or in patients with rapid clinical deterioration[3] . Applying the standard invasive mechanical ventilation (IMV) means confronting the patient with all the side effects and complications following endotracheal intubation [3]

complications include: damage to the trachea caused by endotracheal tube producing ulceration, oedema and haemorrhage that can lead to tracheal stenosis [4]. There are also potential complications of this MV method eg damage to the face and nose skin, gastric distension with aspiration risk, sleeping disorders and conjuctivitis[5]

Noninvasive mechanical ventilation (NIMV) presents an alternative to conventional IMV through an endotracheal tube, both in early stage of ARF as well as in patients with severe diseases[6,7]

It includes similar techniques for alveolar ventilation improvement to those of IMV, but without endotracheal intubation[8].But Conditions that limit NIMV application are: coma, unstable respiratory centre, swallowing disorders, mental immaturity, face deformations, shock and cardiorespiratory arrest.Since as per the hospital protocol if the patient is conscious ,having saturation of more than 84%,pao2 of more than 65 mmHg pand aco2 0f less than 55 mmHg early trial of NIV ventilatiom'n is given

NIV is particularly indicated in: COPD with a respiratory acidosis pH 7.25–7.35 (H+ 45–56 nmol/l) Hypercapnic respiratory failure secondary to chest wall deformity (scoliosis, thoracoplasty) or neuromuscular diseases Cardiogenic pulmonary oedema unresponsive to CPAP Weaning from tracheal intubation NIV is not indicated in: Impaired consciousness Severe hypoxaemia Patients with copious respiratory secretions The benefits of an acute NIV service are likely to be: Fewer patients referred to intensive care for intubation Shorter stays on intensive care Fewer deaths of patients with acute respiratory failure [Visit the BTS and ARTP websites (brit-thoracic.org.uk and artp.org.uk) for: The BTS recommendations on NIV.]

INCLUSION CRITERIA: age between 30-65 of both the genders Presented with acute breathlessness with oxygen saturation between 80-90% in pre exixting COPD status,patients should be Conscious , COPD with a respiratory acidosis pH 7.25–7.35 (H+ 45–56 nmol/l) Hypercapnic respiratory failure secondary to chest wall deformity (scoliosis, thoracoplasty) or neuromuscular disease

EXCLUSION CRITERIA: coma, unstable haemodynamics inspite of support , swallowing disorders, mental immaturity, face deformations, shock and cardiorespiratory arrest,patients who are non cooperative for sustained NIV and who couldnot affoed to purchase appropriate sized mask

MATERIALAND METHODS:

A retrospective analysis was done to ascertain the effect of early NIV on the respiratory improvement of patient in acute respiratory insufficiency .As per the guidelines laid down by the thorasic society[2002 GUIDELINES]] and as per the institutional protocol NIV was used as a therapeutic modality..The effect was stastistically analysed .40 patients of COPD were studied retrospectively.Out of them Group A comprises of 20 patients who were ventilated with NIV (Bipap) and othe Group B comprises of 20 patients who were not been given appropriate NIV for required stipulated time due to various factors .Although group B candidates fulfill the criteria for NIV but the patients were either extremely uncooperative , highly apprehensive about the NIV system ,unable to purchase appropriate sized mask .This caused inappropriate use of NIV in proper stipulated time required in group B patients

OBSERVATIONS :

Demographic data:

	GROUP A	GROUP B	P VALUE
Age	45±10.4	46.32±12.1	0.3
Weight	40.22±3.7	40.20±3.1	0.6
BMI	27.36±0.06	28.02±0.05	0.3
% PTS WITH H/O Smoking	39.64±8.2	35.82±8.0	0.1
APACHE SCORE	19.34±0.06	20.2±0.05	0.3

P Value Of Above Parameters : Statistically Insignificant

Comparision Of Respiratory Parameters On Admission

	Group A	Group B	P VALUE
Tidal volume	320±8	332±7.9	0.1
Respiratory rate	26±3.3	28±3.41	0.3
pH	7.31±2.2	7.29±1.9	0.1
Paco2	54.5±0.5	53.9±0.48	0.1
Spo2	87±2.8	88±2.7	0.6

P Value Of Above Parameters =statistically Insignificant

Comparision of respiratory parameters after 48 hrs of precise NIV support

	Group A	Group B	P VAUE
Tidal volume	418±3.2	340±1.42	SIGNIFICANT
Respiratory rate	20±2.11	26±3.7	SIGNIFICANT
pH	7.39±3.6	7.22±1.9	SIGNIFICANT
Paco2	39.4±12.6	53.6±10.22	SIGNIFICANT
Spo2	94±0.8	87.31±2.2	SIGNIFICANT

P Value<0.001=significant

DISCUSSION:

Background

One of the first descriptions of the use of NIV using nasal masks was for the treatment of hypoventilation at night in patients with neuromuscular disease.[9,10]This has proved to be so successful that it has become widely accepted as the standard method of non-invasive ventilation used in patients with chronic hypercapnic respiratory failure caused by chest wall deformity, neuromuscular disease, or impaired central respiratory drive. It has largely replaced other modalities such as external negative pressure ventilation and rocking beds. Within a few years of its introduction, NIV was starting to be used in acute hypercapnic respiratory failure and in patients with abnormal lungs rather than an impaired respiratory pump. Initial anecdotal reports were followed by larger series and then by randomised trials. Analysis of these trials has shown that NIV is a valuable treatment for acute hypercapnic respiratory failure, as will be discussed further.

In assisted spontaneous breathing (ASB) the patient's respiratory effort triggers the ventilator both on and off. Respiratory frequency and the timing of each breath are therefore determined by the patient. As this mode usually involves setting pressure, it is often termed pressure support (PS). If the patient fails to make respiratory effort, no respiratory assistance will occur, although many manufactures now incorporate a back up rate of 6–8 breaths per minute. Continuous positive airway pressure CPAP is employed in patients with acute respiratory failure to correct hypoxaemia. It permits a higher inspired oxygen content than other methods of oxygen supplementation, increases mean airway pressure, and will improve ventilation to collapsed areas of the lung. The recruitment of underventilated lung is similar to the use of positive end expiratory pressure (PEEP) in the intubated mechanically ventilated patient. CPAP also unloads the inspiratory muscles and thereby reduces inspiratory work, although in hyperinflated patients with airflow obstruction any further increase in lung volume produced by CPAP may have an adverse effect on the function of the inspiratory muscles. In cases of respiratory failure due to exacerbations of COPD, the offsetting of intrinsic PEEP by CPAP (see below) may reduce ventilatory work resulting in a slowing of respiratory rate, an increase in alveolar ventilation, and a fall in PaCO2. Although this might be considered the result of respiratory assistance, conventionally CPAP is not considered respiratory support and its main indication is to correct hypoxaemia. Flow generators employed in CPAP need to be capable of maintaining the desired pressure throughout the respiratory cycle. In domiciliary practice, as in the treatment of obstructive sleep apnoea (OSA), generators capable of low flows are sufficient as minute ventilation and peak inspiratory flow are low. In the distressed COPD patient the increased minute ventilation, high frequency, and short inspiratory time may result in peak inspiratory flow rates in excess of 60 l/min. High flows are therefore required to prevent a fall in applied pressure. Some of the newer non-invasive ventilators have a CPAP mode capable of delivering adequate flow rates. Other CPAP generators require a high pressure oxygen supply. Whisper flow systems entrain room air by the Venturi effect and 196 BTS Standards of Care Committee www.thoraxjnl.com on September 1, 2019 at India:BMJ-PG Sponsored. Protected by copyright. http://thorax.bmj.com/ Thorax: first published as 10.1136/thorax.57.3.192 on 1 March 2002. Downloaded from have a FiO2 adjustable above a minimum 40%. The Draeger system provides for a lower FiO2 as air and oxygen is independently set. A reservoir prevents a fall in mask pressure during inspiration. CPAP masks are usually pressurised by inserting a one way exhalation valve. Bi-level pressure support In NIV, pressure support and CPAP are often used in combination as bi-level pressure support. Ventilation is produced by the inspiratory positive airway pressure (IPAP), while the expiratory positive airway pressure (EPAP) recruits underventilated lung and offsets intrinsic PEEP (with beneficial effects on triggering). The EPAP also serves to vent exhaled gas through the exhaust port (see below). Proportional assist ventilation Proportional assist ventilation (PAV) is an alternative technique in which both flow—to counter resistance—and volume—to counter compliance—are independently adjusted. It may improve patient comfort and so improve success and compliance with acute NIV[11]

NON-INVASIVE VENTILATORS Ventilators employed in NIV range from ICU ventilators with full monitoring and alarm systems normally employed in the intubated patient, to light weight, free standing devices with limited alarm systems specifically designed for non-invasive respiratory support. Life support ICU ventilators separate the inspiratory and expiratory gas mixtures. This prevents rebreathing and allows monitoring of inspiratory pressure and exhaled minute ventilation on which monitoring and alarm limits are based. In NIV single tubing is usually employed, and exhalation is either active

(the ventilator opens an exhalation valve—for example, NIPPY 1 or Breas PV 401) or passive (exhaled air is encouraged to exit an exhaust valve or port by continuous bias flow (EPAP) from the ventilator). Exhalation valves may increase work of breathing, and normally used EPAP levels (3–5 cm H2O) do not completely eliminate rebreathing during bi-level pressure support, especially when respiratory frequency increases.[12] This therefore needs to be considered in the tachypnoeic anxious individual who fails to improve or develops worsening hypercapnia. It is important that exhalation ports or valves are fitted and functioning properly. Occlusion of the exhaust port—for instance, by sputum—can exacerbate hypercapnia through rebreathing.[13]Volume assist-control ventilators Volume controlled ventilators predominated in the past but have largely been replaced by pressure devices. Some air leak is invariable with NIV, either from the mask or through the mouth, and with a volume controlled ventilator tidal volumes must be arbitrarily increased to compensate for this. Volume and pressure control modes have both been shown to be effective in COPD but few comparative studies have been reported. Vittaca et al[14] found no difference in outcome whether volume or pressure ventilators were used in AHRF. Girault et al found greater respiratory muscle rest with volume assist, but at the cost of greater patient discomfort compared with PS.[15] The addition of PEEP to PS was not investigated, however, which might have reduced work of breathing. Some experts would wish to use a volume ventilator for the more difficult patient and Schoenhofer et al reported that some patients failed to be managed with pressure timed support but were successfully treated by volume control[16] One explanation might be that volume control is better at ensuring alveolar ventilation when compliance or airway resistance changes. This is probably not important in acute NIV as patient monitoring would detect failure to correct hypercapnia. Similarly, glottic narrowing, which may limit the effectiveness of the timed mode as the glottic aperture will not be in phase with mechanical breaths[17,18] is probably only of relevance to domiciliary practice. Pressure assist-control ventilators Technical developments such as microprocessor controlled valves have led to most NIV ventilators now being pressure controlled flow generators. Smith and Shneerson carried out a bench comparison of ventilators and showed the expected better leak compensation of pressure control.[18]The deaccelerating flow profile of a pressure controlled breath may result in better distribution of ventilation while, in the ICU, recognition of subtle forms of ventilator associated lung damage has resulted in a move to pressure limited small volume ventilation. This is typified by the recruiting "permissive" hypercapnia ventilation strategies now recommended in acute COPD. and NIV Number of prospective randomised controlled trials of NIV have been published, predominantly in patients with acute exacerbations of COPD. The studies performed in the ICU;[19,20,21,22]show that NIV is feasible and that the tracheal intubation rate is substantially reduced. In the study by Brochard et al [20] most of the excess mortality and complications, particularly pneumonia, were attributed to intubation. These data suggest that NIV may be superior to mechanical ventilation but, importantly, this was a highly selected group of patients with the majority being excluded from the study. Kramer et al[19] also noted a reduction in intubation rate, particularly in the subgroup with COPD, but with no difference in mortality. The study by Celikel et al[21] showed a more rapid improvement in various physiological parameters but there was no difference in intubation rate or survival. However, a number of patients in the conventionally treated group also received NIV because of clinical deterioration. Martin et al[22] have recently reported a prospective randomised controlled trial comparing NIV with usual medical care in 61 patients including 23 with COPD. In common with other studies there was a significant reduction in intubation rate, but there was no difference in mortality. However, generalisation of these results to the UK, where NIV is usually performed on general wards, is uncertain. Prospective randomised controlled trials of NIV outside the ICU[23,24,25,26]have shown varying results. In the trial by Bott et al[25] research staff supernumerary to the normal ward complement initiated NIV. On an intention to treat analysis there was no difference between the two groups, but when those unable to tolerate NIV were excluded a significant survival benefit was seen in the NIV group. In the study by Barbe et al[24]the lack of difference between the two groups is not surprising as, given the modest level of acidosis at presentation, the majority were likely to improve with standard treatment. Wood et al[23] found a non-significant trend towards increased mortality in those given NIV (4/16 v 0/11, p=0.123) which was attributed to delays in intubation. It is difficult to draw many conclusions from this study as the two groups were poorly matched and the numbers small. In particular, there were more patients with pneumonia in the NIV group.

A multicentre randomised controlled trial of NIV in acute exacerbations of COPD (n=236) on general respiratory wards in 13 centres has recently been reported.30 NIV was applied by the usual ward staff according to a simple protocol. "Treatment failure", a surrogate for the need for intubation defined by a priori criteria, was reduced from 27% to 15% by NIV (p50 nmol/l) after initial treatment was inferior to that in the studies performed in Non-invasive ventilation in acute respiratory failure 199 www.thoraxjnl.com on September 1, 2019 at India:BMJ-PG Sponsored. Protected by copyright. http://thorax.bmj.com/ Thorax: first published as 10.1136/thorax.57.3.192 on 1 March 2002. Downloaded from the ICU; these patients are probably best managed in a higher dependency setting with individually tailored ventilation. Staff training and support are crucial wherever NIV is performed, and operator expertise more than any other factor is likely to determine the success or otherwise of NIV. It is important to note that all the randomised controlled trials have excluded patients deemed to warrant immediate intubation and mechanical ventilation and there has been no direct comparison between NIV and invasive ventilation from the outset in COPD. In addition to these prospective randomised controlled trials, there have been two studies comparing patients treated with NIV with historical controls treated conventionally or with invasive mechanical ventilation. These have shown a reduction in intubation rate,[27] no difference in hospital mortality, but a survival advantage for non-invasively ventilated patients becoming apparent after discharge at 3 months and 1 year.[28]

CONCLUSION:

NIV proves to be an effective modality for acute respiratory insufficiency in COPD patients Need of invasive ventilation is prevented and thereby its complications .Since initial improvement encourages the patients for further cooperation and creates vicious cycle of positive events.It is recommended to start NIV support early to obtain better clinical outcome.

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