Impact of Non-Invasive Ventilation on the outcome of the extubated chronic hypercapnic patients in the Respiratory Intensive Care Unit at Ain Shams University specialized Hospital

Thesis

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Abbreviations

%	Percent
≥	More than or equal to
<	Less than
>	More than
≤	Less than or equal to
°C	degree Celsius
ABG	Arterial blood gas analysis
AE	Acute Exacerbation
AHRF	Acute hypercapnic respiratory failure
ALS	Amyotrophic lateral sclerosis
APRV	Airway pressure–release ventilation
ARDS	Acute Respiratory Distress Syndrome
ARF	Acute respiratory failure
ASD	Atrial septal defect
ATS	American Thoracic Society
BiPAP	Bi-level positive airway pressure
BMI	Body mass index
bpm	Breath per minute
CaO2	Arterial oxygen content
CBC	Complete blood count
CcO2	Capillary oxygen content
CHRF	Chronic hypercapnic respiratory failure
cm	Centimeter
CNS	Central nervous system
CO2	Carbon dioxide
COPD	Chronic Obstructive Pulmonary Disease
CPAP	Continuous positive airway pressure
CvO2	Mixed venous oxygen content
CWD	Chest wall diseases
DILD	Diffuse interstitial lung diseases
dL	Deciliter
e.g	Example given
ECG	Electrocardiography
ePEEP	Extrinsic positive end-expiratory pressure

ERS	European respiratory society
ETT	Endotracheal Tube
f R	Respiratory frequency
FEV1	Forced expiratory volume in 1st second
Fig	Figure
FiO2	Fraction of inspired oxygen
FRC	Functional residual capacity
FVC	Forced vital capacity
g	Gram
H2O	Water
Hb	Hemoglobin
HCO3	Bicarbonate
Hg	Mercury
HRF	Hypercapnic respiratory failure
i.e	id est (that is)
I/E	Inspiratory–expiratory ratio
ICU	Intensive Care Unit
ILD	Interstitial lung disease
IMV	Intermittent mandatory ventilation
iPEEP	Intrinsic positive end-expiratory pressure
K	Constant
Kg	Kilogram
L	Liter
m2	Meter square
min.	Minute
MIP	Maximal inspiratory pressure
ml	Milliliter
mm	millimeter
MRSA	Methicillin Resistant Staphylococcus aures
MV	Mechanical Ventilation, Minute ventilation
NAVA	Neurally adjusted ventilatory assist
NIV	Non-invasive ventilation
NMD	Neuro-muscular disorders
NSIP	Non-specific interstitial pneumonia
O2	Oxygen
OHS	Obesity hypoventilation syndrome
OSAHS	Obstructive sleep apnea hypopnea syndrome

P	Probability
PaCO2	Partial arterial carbon dioxide Pressure
PAO2	Pressure of alveolar oxygen
PaO_2	Partial arterial Oxygen Pressure
Patm	Barometric atmospheric pressure
PAV	Proportional assist ventilation
PC	Personal Computer
PEEP	Positive end-expiratory pressure
PFTs	Pulmonary function tests
pH	Power of Hydrogen
PH2O	Water vapor pressure at 37°C
PiO2	Pressure of inspired oxygen
PO2	Partial pressure of oxygen
PRVC	Pressure-regulated volume-control ventilation
PSV	Pressure support ventilation
Qs/Qt	The shunt fraction
R	Respiratory exchange ratio
r	Coefficient of correlation
RICU	Respiratory Intensive Care Unit
RQ	Respiratory quotient
RSBI	Rapid shallow breathing index
SaO2	Arterial oxygen saturation
SBT	Spontaneous breathing trial
SD	Standard deviation
SIMV	Synchronized intermittent mandatory ventilation
t	Student T test
Ti	Inspiratory time
UIP	Usual interstitial pneumonia
V/Q	Ventilation / Perfusion ratio
VA	Alveolar ventilation
VAP	Ventilator Associated Pneumonia
VCO2	Carbon dioxide production
VSD	Ventricular septal defect
VSV	Volume-support ventilation
VT	Tidal volume
$\chi 2$	Chi-Square test

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INTRODUCTION

Respiratory failure is a syndrome in which the respiratory system fails in one or both of its gas exchange functions: oxygenation and carbon dioxide elimination. In practice, it may be classified as either hypoxemic or hypercapnic **(Lanken P, 1995)**.

Respiratory failure may be further classified as either acute or chronic. Although acute respiratory failure is characterized by life-threatening derangements in arterial blood gases and acid-base status, the manifestations of chronic respiratory failure are less dramatic and may not be as readily apparent **(MacSweeney R. et al, 2011)**.

The need for mechanical ventilation (MV) is a frequent reason for admission to an intensive care unit (ICU). The principal indications for MV are airway protection and respiratory failure which are considered the most common vital organ failure seen in critically ill patients. Among ICU patients, 40–65% need MV during their ICU stay. Patients receiving MV require a complex, well-organized, and technically sophisticated level of care **(Reddy R and Guntupalli K, 2007)**.

Use of Non-invasive ventilation (NIV) may provide a means of reducing the duration of invasive mechanical support for intubated patients with ARF. Unlike for conventional invasive ventilation, NIV is achieved with an oro-nasal, nasal or total face mask connected to a ventilator and does not require an indwelling artificial airway. Through NIV one can (i) administer oxygen, (ii) augment the inhaled volume and (iii) apply extrinsic positive end-expiratory pressure (ePEEP) to counteract intrinsic positive end-expiratory pressure (iPEEP) **(Ambrosino N and Vagheggini G, 2008)**.

AIM OF THE WORK

The aim of this work was to study the impact of non-invasive ventilation on the outcome of the extubated chronic hypercapnic patients and comparing it versus conventional Oxygen therapy in the Respiratory Intensive Care Unit at Ain Shams University Specialized Hospital during the period from October 2013 till May 2015.

Overview on Respiratory Failure

Definition:-

Respiratory failure can be defined as a condition in which the respiratory system fails in one or both of its main gas exchanging functions; which are oxygenation of, and carbon dioxide elimination from, mixed venous (pulmonary arterial) blood. Hence, respiratory failure is considered to be a syndrome rather than a single disease **(Lanken P, 1995)**.

In clinical practice, respiratory failure is defined as an arterial oxygen tension (PaO2) value of less than 60 mm Hg while breathing room air with or without an arterial carbon dioxide tension (PaCO2) of more than 50 mm Hg. These values are measured using arterial blood gases analysis **(MacSweeney R. et al, 2011)**.

Classification of respiratory failure:-

Respiratory failure can be classified using different classifications.

1- **According to PaO2 and PaCO2 levels:-**

■**Type 1 (hypoxemic) respiratory failure**:

It is characterized by an arterial oxygen tension (PaO2) lower than 60 mm Hg with a normal or sometimes low arterial carbon dioxide tension (PaCO2). This is considered the most common type of respiratory failure, and it can be caused with almost all acute diseases of the lungs, which generally involve fluid filling or collapse of alveolar units. Some examples of conditions associated with type 1 respiratory failure are cardiogenic or non-cardiogenic pulmonary edema, pneumonia, and pulmonary hemorrhage **(Confalonieri M. et al, 1999)**.

■**Type 2 (hypercapnic) respiratory failure**:

In this type, the level of arterial carbon dioxide tension (PaCO2) is higher than 50 mm Hg. Hypoxemia is usually common in patients with hypercapnic respiratory failure who are breathing room air. The pH depends on the level of bicarbonate anion, which, in turn, is dependent on the duration over which the hypercapnia has developed. Common etiologies include drug overdose, neuromuscular disease, chest wall abnormalities, and severe airway disorders (eg, asthma and chronic obstructive pulmonary disease [COPD]) **(Plant P. et al, 2000).**

■**Type 3 (Peri-Operative) respiratory Failure:**

In this type, the increased atelectasis due to low functional residual capacity (FRC) which is usually caused by abnormal abdominal wall mechanics in the peri-operative period often results in type 1 or type 2 respiratory failure and can be prevented by: selecting anesthetic or operative technique, posture, incentive spirometry, adequate post-operative analgesia, attempts to lower intra- abdominal pressure **(Glossop A. et al, 2012)**.

■**Type 4 (Shock) respiratory Failure:**

Type 4 describes respiratory failure occurring in patients who are intubated and ventilated during management of shock. The ultimate goal of ventilation of those patients is to stabilize gas exchange and to remove the burden of respiratory muscles, lowering their oxygen consumption **(Midelton G. et al, 2002).**

2- According to duration of development:-

Respiratory failure can be classified on the basis of the duration over which it has developed into either acute or chronic respiratory failure. Although acute respiratory failure is often associated with life-threatening abnormalities in arterial blood gases and acid-base balance, the manifestations of chronic respiratory failure are less dramatic and may not be as readily apparent **(MacIntyre N, Huang Y, 2008).**

In case of acute hypercapnic respiratory failure, the condition develops over the period of minutes to hours; therefore, pH is less than 7.3 as there is no time available for renal compensation while in chronic respiratory failure which develops over several days or longer, allowing time for renal compensation and an increase in bicarbonate concentration. Therefore, the pH usually is only slightly decreased **(Brochard L. et al, 1995).**

In contrast to hypercapnic respiratory failure, The differentiation between acute and chronic hypoxemic respiratory failure cannot easily be made using the analysis of arterial blood gases, so, The use of clinical markers of chronic hypoxemia, such as polycythemia or cor pulmonale, suggest a long-standing disorder indicating chronicity **(Esan A. et al, 2010).**

Table (1): Distinctions between Acute and Chronic Respiratory Failure

Category	Characteristic
Hypercapnic respiratory failure	Pa_{CO_2} >45 mm Hg
Acute	Develops in minutes to hours
Chronic	Develops over several days or longer
Hypoxemic respiratory failure	Pa_{O_2} <55 mm Hg when F_{IO_2} ≥0.60
Acute	Develops in minutes to hours
Chronic	Develops over several days or longer

(Source: Grippi A. et al, 2015)