EFFECT OF MANUAL HYPERINFLATION ON SELECTED ARTERIAL BLOOD GASES IN MECHANICALLY VENTILATED PATIENTS

Thesis

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BY

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Abstract

The aim of this study was to investigate the effect of manual hyperinflation on selected arterial blood gases in mechanically ventilated patients. Forty mechanically ventilated patients were randomly selected from Cairo university hospitals (critical care department), their ages ranged from 40 to 60 years. They were divided into two equal groups study and control group ,twenty patients for each group, each patient of the study group received both manual hyperinflation for 15 min and chest physiotherapy for 15 min with frequency thee sessions per day for three successive days, each patient of the control group received only chest physiotherapy for 15 min with frequency three sessions per day for three successive days , Pre and post study arterial blood gases assessment was done for each patient of both groups , the result of our study revealed statistically difference in selected arterial blood gases that showed improvement in patients in both control and study group but this improvement was high statistically significant in study group only , So, it is recommended to use manual hyperinflation with chest physiotherapy in order to improve the arterial blood gases in mechanically ventilated patients

Key words: manual hyperinflation, arterial blood gases, mechanically ventilated patients.

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LIST OF ABBREVIATIONS

ABG	Arterial Blood Gas
ALI	acute lung injury
ARDS	acute respiratory distress syndrome
CCU	Critical care unite.
C_L	Compliance
Co	Carbon monoxide
Co_2	carbon dioxide
Cao_2	Arterial O2 Content
CRT	Continuous rotational therapy
ET	end tracheal tube
FiO2	Fraction of inspired oxygen
HCO3	Bicarbonate
I:E	inspiratory:expiratory
ICU	Intensive care unite
MAP	mean arterial pressure
MHI	Manual hyperinflation
mmHg	Millimeter Mercury
MV	mechanical ventilation
$PaCO_2$	Carbon dioxide partial pressure
PaO_2	Arterial oxygen partial pressure
PEEP	Positive end expiratory pressure
pH	Measure hydrogen ion in blood
RAW	Airway resistance
SaO_2	Arterial oxygen saturation
SpO_2	saturation of hemoglobin in peripheral (capillary) blood
V/Q	ventilation/perfusion
VAP	ventilator-associated pneumonia
Vt	tidal volume
WOB	work of breathing

Definition of terms

Mechanical ventilation is a method to mechanically assist or replace spontaneous breathing when patients cannot do so on their own, and must be done, so after invasive intubation with an endotracheal or tracheostomy tube through which air is directly delivered, In many cases mechanical ventilation is used in acute settings such as in the ICU for a short period of time during a serious illness. For some patients who have certain chronic illnesses that require long-term ventilation assistance**(Suzanne, 2006).**

The process of weaning critically ill adults from mechanical ventilation refers to the gradual discontinuation of mechanical ventilation. Although a variety of approaches are available to wean patients from mechanical ventilation, evidence from clinical trials suggests that protocol-directed weaning consistently reduces duration of mechanical ventilation, reduces ventilator-associated complications, and reduces the rate of re-intubation **(Suzanne, 2006).**

ventilator-associated pneumonia, defined as parenchymal lung infection occurring at least 48 hours after initiation of mechanical ventilation, is one reason for high costs and prolonged length of stay in the intensive care unit (ICU)

,Ventilator-associated pneumonia is associated with symptoms such as fever, leucocytosis or leucopenia, purulent sputum and the presence of new and persistent pulmonary infiltrates**(Moorehead and Pinto, 2000)**.

Manual Hyperinflation manually inflating the patient's lungs with tidal volumes 50% greater than those delivered by the ventilator is advocated to mobilize secretions in peripheral bronchi, to prevent and treat atelectasis, and to improve oxygenation **(Singer, 1994)**.

Ventilator Hyperinflation Ventilator hyperinflation is achieved by altering the ventilatory settings to gradually increase tidal volume. It may produce the same effects as manual hyperinflation whilst maintaining the positive end expiratory pressure (PEEP) level and controlling airway pressure limits **(Denehy and berney, 2006).**

Respiratory failure is nearly any condition that affects breathing function or the lungs themselves and can result in failure of the lungs to function properly. The main tasks of the lungs and chest are to get oxygen from the air that is inhaled into the bloodstream and, at the same time, to eliminate carbon dioxide (Co_2) from the blood through air that is exhaled out. In respiratory failure, the level of oxygen in the blood becomes dangerously

low, and/or the level of Co_2 becomes dangerously high. There are two ways in which this can happen. Either the process by which oxygen and Co_2 are exchanged between the blood and the air spaces of the lungs (a process called "gas exchange") breaks down, or the movement of air in and out of the lungs (ventilation) does not take place properly **(Mason et al., 2005).**

Arterial Blood Gas Test (ABG) the test that tells the health professional how lungs are working. It is very sensitive to changes in breathing patterns and is used to establish treatment for your condition and qualify for home oxygen therapy. The arterial oxygen and carbon dioxide pressure levels are measured in millimeters of mercury. The percent age of oxygen that is carried in the blood is also measured, it include the following parameter according to **Aaron et al., (2003)**

- **Arterial oxygen pressure (PaO_2) –** the normal partial pressure of arterial oxygen ranges from 75 to100 mmHg.
- **Carbon dioxide partial pressure ($PaCO_2$) –** the normal partial pressure of carbon dioxide in the arterial blood ranges from 35–45 mm Hg.
- **Oxygen saturation ($Sa\ O_2$)%**

  The percentage of hemoglobin binding sites in the blood stream occupied by oxygen. Normal range from 92 % to 100 % ,Less than 90 % termed hypoxemia.

- **PaO_2 / FiO_2 ratio** (percentage of O_2 pressure to fraction inspired O_2) Normally 400-500 % , A PaO_2/FiO_2 ratio ≤ 200 are used in the diagnosis of acute lung injury (ALI) and acute respiratory distress syndrome.

The mean arterial pressure (**MAP**) is a term used in medicine to describe the average of blood pressure in an individual. It is defined as the average arterial pressure during a single cardiac cycle , Normal range (70-90 mm Hg).

MAP =diastolic blood pressure + 1/3 pulse pressure

= diastolic blood pressure +1/3 (systole – diastole)

MAP is considered to be the perfusion pressure seen by organs in the body. It is believed that a MAP that is greater than 60 mmHg is enough to sustain the organs of the average person. If the MAP falls significantly below this number for an appreciable time, the end organ will not get enough blood flow, and will become ischemic **(Kelvens et al., 2007)**

Pulmonary Compliance – A measure of the elasticity of the lung. A less compliant lung (stiffer) requires higher inspiratory pressures to maintain ventilation. Technically, compliance describes the elastic properties of the lung measured as change in volume divided by change in pressure. Thus, the greater the compliance the larger the delivered volume can be per unit of pressure. Lung compliance is measured in mL/cm of H2O.

Pulmonary compliance C =V / P (V is change in volume , P is change in pressure)**(Nikischin et al., 1998)**

Positive end-expiratory pressure (PEEP) refers to pressure in the airway at the end of passive expiration that exceeds atmospheric pressure. The term is applicable to patients receiving mechanical ventilation.

Normal value range from 5 cm H2O to 20 cm H2O,Usually it improves oxygenation , Stabilizes and recruits lung units , Improves lung compliance ,and Minimizes potential for ventilator induced lung injury , It may cause barotraumas(rupture of alveoli) **(Richard et al., 2001).**

Acidosis is an increased acidity (i.e. an increased hydrogen ion concentration). If not further qualified, it usually refers to acidity of the blood plasma,Acidosis is said to occur when arterial pH falls below 7.35, while its counterpart (alkalosis) occurs at a pH over 7.45. Arterial blood gas analysis and other tests are required to separate the main causes.

The term acidemia describes the state of low blood pH, while *acidosis* is used to describe the processes leading to these states. Nevertheless, physicians sometimes use the terms interchangeably. The distinction may be relevant where a patient has factors causing both acidosis and alkalosis, where the relative

severity of both determines whether the result is a high or a low pH **(Needham, 2004).**

Alkalosis refers to a condition reducing hydrogen ion concentration of arterial blood plasma (alkalemia). Generally alkalosis is said to occur when pH of the blood exceeds 7.45. The opposite condition is acidosis**(Needham, 2004)**

Acute respiratory distress syndrome (**ARDS**), also known as **respiratory distress syndrome** (**RDS**) or **adult respiratory distress syndrome** (in contrast with IRDS) is a serious reaction to various forms of injuries to the lung,ARDS is a severe lung disease caused by a variety of direct and indirect issues. It is characterized by inflammation of the lung parenchyma leading to impaired gas exchange with concomitant systemic release of inflammatory mediators causing inflammation, hypoxemia and frequently resulting in multiple organ failure. This condition is often lethal, usually requiring mechanical ventilation and admission to an intensive care unit. A less severe form is called acute lung injury (**ALI**),ARDS formerly most commonly signified adult respiratory distress syndrome to differentiate it from infant respiratory distress syndrome in premature infants. However, as this type of pulmonary edema also occurs in children, ARDS has gradually shifted to mean acute rather than adult. The differences with the typical infant syndrome remain **(Irwin and Rippe, 2003)**.

Carboxyhemoglobin (British English: **Carboxyhaemoglobin**) (COHb) is a stable complex of carbon monoxide and hemoglobin that forms in red blood cells when carbon monoxide is inhaled, and hinders delivery of oxygen to the body. Tobacco smoking (through carbon monoxide inhalation) raises the blood levels of COHb ,In large quantities, the effect of COHb is death - known medically as carboxyhemoglobinemia or carbon monoxide poisoning. However in smaller quantities COHb leads to oxygen deprivation of the body causing tiredness, dizziness and unconsciousness.

Hemoglobin bonds to carbon monoxide preferentially (200:1 more so) compared to bonding to oxygen, so effectively, COHb will not release the carbon monoxide, and therefore hemoglobin will not be available to transport oxygen from the lungs to the rest of the body. However, animals, such as a human, should survive with very small amounts of COHb in their blood with very little or no observable effects.

COHb has a half-life in the blood of 4 to 6 hours. COHb increases risk of blood clot. It is thought that through this mechanism smoking increases the risk of having an ischemic stroke (**Denshaw-Burke and Mary, 2006)**