

Monitoring of Respiratory Function During Mechanical Ventilation

An Essay

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Dalia Yousef

List of Abbreviation:

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Abbreviation	Meaning
[(A-a) O ₂]	Alveolar arterial oxygen gradient.
ABGs	Arterial Blood Gases.
ACV	Assist/Controlled Ventilation.
ALI	Acute Lung Injury.
APRV	Airway Pressure Release Ventilation.
ARDS	Acute Respiratory Distress Syndrome.
ARF	Acute Respiratory Failure.
BiPAP	Bilevel Pressure Ventilation.
C	Compliance.
C _a	Oxygen Content In Arterial Blood.
C _{ao2}	O ₂ Content of Arterial Blood.
C _c	Oxygen Contents of End-Capillary Blood.
C _{c'o2}	O ₂ Content of End Capillary Blood.
C _{dyn,L}	Dynamic Lung Compliance.
C _{dyn}	Dynamic Compliance of Respiratory System.
cGMP	Cyclic Guanosine Monophosphate.
CL	Lung Compliance.
-Cl	Chloride Ions.
cm H ₂ O	Centimeter Water.
CMV	Continuous Mandatory Ventilation.
CNS	Central Nervous System.
CO ₂	Carbon Dioxide.
COHb	Carboxyhemoglobin.
COPD	Chronic Obstructive Pulmonary Disease.
CPAP	Continuous Positive Airway Pressure.
CROP	Compliance, Rate, Oxygen, pressure (integrative weaning index). C _{vo2} O ₂ Content of Mixed Venous Blood.
C _{st}	Static Compliance.
C _v	Oxygen Content In Mixed Venous Blood.
CVS	Cardio Vascular System.

List of Abbreviation:

CW	Chest Wall Compliance.
C_{xO_2}	Oxygen Content Arterial And Venous Blood.
DP	Driving pressure.
E	Elastance.
ECG	Electrocardiographic.
Edyn,rs	Dynamic Elastance of the Respiratory System.
EMG	Electromyographic.
ENT	Ear Nose Throat.
EPAP	Expiratory Positive Airway Pressure.
ERV	Expiratory Reserve Volume.
Est,rs	Elastance of the Respiratory System.
ETCO ₂	End-Tidal Carbon Dioxide.
ET-tube	Endo Tracheal Tube.
F _I O ₂	Concentration of Inspired Oxygen.
<i>f</i> _{mv}	Ventilator Rate.
forc	Respiratory Muscle Function.
FRC	Functional Residual Capacity.
FVC	Forced Vital Capacity.
GCS	Glasgow Coma Scale.
H ⁺	Hydrogen Ions.
HCO ₃ ⁻	Bicarbonate Ions.
HFJV	High Frequency Jet Ventilation.
HFO	High Frequency Oscillation.
HFPPV	High Frequency Positive Pressure Ventilation.
HFV	High Frequency Ventilation.
Hz	Hertz.
I:E	Inspiratory Time To Expiratory Time.
ICUs	Intensive Care Unites.
IMV	Intermittent Mandatory Ventilation.
IPAP	Inspiratory Positive Airway Pressure.
IRV	Inverse Ratio Ventilation.
IRV	Inspiratory Reserve Volume.
K	Constant.

List of Abbreviation:

L/min	Litter per Minute.
LIP	Lower Inflection Point.
mg/dL	Milligram Per Deciliter.
MIP	Maximal Inspiratory Pressure.
mmHg	Millimeter Mercury.
MMV	Mandatory Minute Ventilation.
MV	Minute Respiratory Volume.
MVV	Maximum Voluntary Ventilation.
NO	Nitric Oxide.
O ₂	Oxygen.
P _{0.1}	Airway Occlusion Pressure Measured at 0.1 Seconds of Occlusion.
Pa	Partial Pressure.
PaCO ₂	Partial Pressures Of Carbon Dioxide.
P-air	Airway Pressure Tracing.
PAo ₂	Partial pressure of Oxygen in alveolar gas.
PaO ₂	Pressures Of Oxygen.
P _{atm}	Partial Pressures of The Atmosphere.
PAV	Proportional Assist Ventilation.
Paw	Airway Pressure.
PCIRV	Pressure Controlled Inverse Ratio Ventilation.
PCV	Pressure Controlled Ventilation.
PEEP	Positive End-Expiratory Pressure.
PEEPi	Intrinsic Positive End Expiratory Pressure.
Pel	Plateau Pressure.
Pes	Pressure In the Esophagus.
P-eso	Esophageal Pressure Tracing.
P _{et} CO ₂	Pressure of End-Tidal Carbon Dioxide.
Pga	Gastric Pressure.
P _{H₂O}	Partial Pressures of Water.
PI _{max}	Maximum Inspiratory Pressure.
Pinit	Initial Pressure.
PIP	Peak Inspiratory Pressure.
P _{mus}	total pressure to baseline with muscle relaxation.

List of Abbreviation:

P _{peak}	Peak Pressure.
P _{pl}	Plural Pressure.
P _{plat}	Plateau Pressure.
PSV	Pressure Support Ventilation.
P _{tp}	Pressure-Time Product.
P-V	Pressure-Volume.
PVR	Pulmonary Vascular Resistance.
Q _s /Q _t	Shunt Fraction.
R	Resistance.
RBCs	Red Blood Cells.
R _{max}	Maximum Resistance.
R _{min}	Minimum Resistance.
RQ	Is The Respiratory Quotient.
RR	Respiratory Rate.
RSBI	Rapid Shallow Breathing Index.
RV	Residual Volume.
SaO ₂	Oxygen Saturation Of Hemoglobin.
SB	Spontaneous Breathing.
sec	Second.
SIADH	Syndrome of Inappropriate Anti-diuretic Hormone.
SIMV	Synchronized Intermittent Mandatory Ventilation.
SpO ₂	Saturation Indicated By the Pulse Oximeter.
S _x O ₂	Are The Saturation Of Arterial And Venous Blood.
TE	Expiratory Time.
T _i	Inspiratory Time.
TI:	Inspiratory Time.
TLC	Total Lung Capacity.
TV _s	Tidal Volumes.
UIP	Upper Infection Point.
υ	volume.
ú	Airway Flows.
[ú] _A	Is Alveolar Ventilation.

List of Abbreviation:

- [\dot{V}]CO₂ Is The Production of Carbon Dioxide In
The Tissues.
- VA Alveolar Ventilation.
- VC Vital Capacity.
- VCO₂ Volume Carbon Dioxide.
- VCV Volume Controlled Ventilation.
- VD Volume dead Air Space.
- VE Minute Ventilation.
- V_T Tidal Volume.
- WI Weaning Index.
- WOB Work of Breathing.

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Introduction

Mechanical ventilators are devices that provide an artificial means of ventilatory support for the respiratory system, their introduction in the modern era has revolutionized the standard of respiratory intensive care medicine by integrating microprocessor-controlled flow rate and pressure waveform dynamics to optimize gas exchange for the critical care patient. (*Michael J. et al, 2007*).

That positive-pressure mechanical ventilation can save lives was proved during the poliomyelitis epidemics of the 1950, since that time there has been a growing increase in the use of ventilatory support, and it has been closely associated with the development of critical care medicine. (*Ibsen, 1952*).

Mechanical ventilation can be lifesaving by maintaining gas exchange until the underlying disorders are corrected, but it is associated with numerous complications, which can significantly affect the outcome of critically ill patients, several advances in monitoring gas exchange ,neuromuscular capacity, respiratory mechanics,

and patient effort during mechanical ventilation have occurred in recent years, monitoring these parameters is helpful in minimizing ventilator-induced complications, optimizing ventilator interaction, and determining a patients readiness for the discontinuation of mechanical ventilation .(*tobin,1998*).

To discuss various techniques that are available to monitoring the respiratory function during mechanical ventilation emphasis on clinical observation and application in critically ill patient.

Aim of the work

To discuss various techniques that are available to monitoring the respiratory function during mechanical ventilation emphasis on clinical observation and application in critically ill patient.

ANATOMY OF THE RESPIRATORY SYSTEM

The respiratory system is divided into the upper respiratory tract and the lower respiratory tract, the upper respiratory tract consists of the parts outside the chest cavity: the air passages consists of the nose, nasal cavities, pharynx, larynx, and upper trachea, the lower respiratory tract consists of the parts found within the chest cavity: the lower trachea, main bronchi and the lungs themselves, which include the bronchial tubes and alveoli. (*Valerie C et al., 2007*).

A)The Upper Airway :

There are two openings to the human airway, the nose and the mouth, the former leads to nasohparynx and the latter leads to oropharynx, they are separated anteriorly by palate, but joined posteriorly at the base of the tongue where the epiglottis prevents aspiration by covering the glottis during swallowing. (*Tina Sanders et al, 2007*).

1. Nose and Nasal Cavities

The nose is made of bone and cartilage covered with skin, The two nasal cavities are within the skull, separated by the nasal septum, which is a bony plate made of the

ethmoid bone and vomer, the nasal mucosa (lining) formed of ciliated epithelium, with goblet cells that produce mucus, three shelf-like or scroll-like bones called conchae project from the lateral wall of each nasal cavity.

The conchae increase the surface area of the nasal mucosa, as air passes through the nasal cavities it is warmed and humidified, so that air that reaches the lungs is warm and moist, bacteria and particles of air pollution are trapped on the mucus; the cilia continuously sweep the mucus toward the pharynx, most of this mucus is eventually swallowed, and most bacteria present will be destroyed by the hydrochloric acid in the gastric juice.

- **Nerve supply of the nose :**

The mucous membrane of the nose innervated by olfactory nerve fibers which carry smell sensation, and by ophthalmic division of trigeminal nerve which carries ordinary sensation.

- **Blood supply of the nose:**

It is supplied by branches of maxillary artery.
(*Tina Sanders et al, 2007*).

2. Pharynx

The pharynx is a muscular tube posterior to the nasal and oral cavities and anterior to the cervical vertebrae, the pharynx divided into three parts.

- Nasopharynx:

It lies above the soft palate, which cuts it from the rest of the pharynx during his deglutition, thus prevents regurgitation of food through the nose, tow important structures lie in this compartment ;orifice of pharyngotympanic or auditory tube (Eustachian canal),nasopharyngeal tonsil (adenoids).

- Orophrynx:

It lies behind the mouth and the tongue, it extends from uvula of soft palate above to the tip of epiglottis below, its most important contents are the palatine tonsils.

- Laryngopharynx:

Is the most inferior portion of the pharynx, it opens anteriorly into the larynx and posteriorly into the esophagus, contraction of the muscular wall of the oropharynx and laryngopharynx is part of the swallowing reflex.

- Nerve supply of the pharynx:

Pharyngeal branches of glossopharyngeal and trigeminal nerves contain the sensory and motor supply

respectively, sensory innervations of nasopharynx is carried by trigeminal nerve. (*Crystal RG et al., 1997*).

3. **Larynx**

The larynx is often called the voice box, a name that indicates one of its functions, which is speaking, the other function of the larynx is to be an air passageway between the pharynx and the trachea, air passages must be kept open at all times, and so the larynx is made of nine pieces of cartilage connected by ligaments, cartilage is a firm yet flexible tissue that prevents collapse of the larynx.

The largest cartilage of the larynx is the thyroid cartilage, which you can feel on the anterior surface of your neck, the epiglottis is the uppermost cartilage, during swallowing, the larynx is elevated, and the epiglottis closes over the top, rather like a trap door or hinged lid, to prevent the entry of saliva or food into the larynx, the mucosa of the larynx is ciliated epithelium, except for the vocal cords (stratified squamous epithelium), the cilia of the mucosa sweep upward to remove mucus and trapped dust and microorganisms.