Adaptive Support Ventilation

“a new dual control mode of mechanical ventilatory support”

Essay

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List of abbreviations

A/C	Assisted controlled
ABG	Arterial blood gases
ACV	Assist control ventilation
ACV	Assisted controlled ventilation
ALI	Acute lung injury
ARDS	Acute respiratory distress syndrome
ASV	Adaptive support ventilation
CC	Closing capacity
COHb	Carboxy-haemoglobin
COPD	Chronic obstructive pulmonary disease
CPAP	Continuous positive airway pressure
CROP	The compliance, rate, oxygen, and pressure
CV	Closing volume
Do_2	Oxygen delivery
ERV	Expiratory reserve volume
F	Frequency
Fio_2	fraction of inspired oxygen
FRC	Functional residual capacity
FV	Flow- volume
HbF	Fetal haemoglobin
IBW	Ideal body weight
IMV	Intermittent Mandatory Ventilation
IRV	Inspiratory reserve volume
I-Time	Inspiratory time
LEDs	Light-emitting diodes
LIP	Low inflection point
metHb	met-haemoglobin
MV	Minute respiratory volume
MVV	Maximum voluntary ventilation
O_2Hb	Haemoglobin oxygen saturation
P0.1	The occlusion pressure measured as inspiratory pressure at100 milliseconds after airway occlusion
$Paco_2$	Arterial partial carbon dioxide pressure
Pao_2	Arterial partial oxygen pressure
PAO_2	Partial alveolar oxygen pressure
PCV	pressure control ventilation

PEEP	Positive end expiratory pressure
PEEPe	extrinsic positive end- expiratory pressure
PEEPi	Intrinsic positive end expiratory pressure
PEFR	Peak expiratory flow rate
PETCO2	partial pressure of end tidal co_2
Phi	Gastric intramucosal PH
Pimax	maximal inspiratory mouth pressure
PIP	peak inspiratory pressure
$PrCO_2$	regional Pco_2
PRVC	pressure regulating volume control
PS	pressure support
$PSLCO_2$	Sublingual Pco_2
Psup	Pressure support
PSV	pressure support ventilation
PSV	pressure support ventilation
PV	pressure-volume
$P\bar{v}CO_2$	mixed venous partial carbon dioxide tension
$P_v O_2$	mixed venous partial oxygen tension
RC	time constant
RR	Respiratory rate
RSBI	Rapid Shallow Breathing Index
RV	Residual volume
SaO_2	Arterial oxygen saturation
SBT	spontaneous breathing test
SIMV	synchronized intermittent mandatory ventilation
$S_v O_2$	mixed venous saturation
TC	Tube compensation
Ti	Inspiratory time
TLC	Total lung capacity
UIP	Upper inflection point
$\dot{V}/Q$	ventilation / perfusion
$\dot{V} O_2$	oxygen consumption
VAP	ventilator-associated pneumonia
VAPS	volume assured pressure support
VC	Vital capacity
VC	volume control
VCV	volume control ventilation
Vd	Dead space
V_E	Minute ventilation

VILI	ventilator-induced lung injury
Vt exp	expiratory tidal volume
Vt insp	inspiratory tidal volume
V_T	Tidal volume
WOB	The work of Breathing

Introduction

In medicine, mechanical ventilation is a method to mechanically assist or replace spontaneous breathing. This may involve a machine called a ventilator or the breathing may be assisted by a physician, respiratory therapist or other suitable person compressing a bag or set of bellows. **(Cabrini et al., 2011).**

Modes of mechanical ventilation are one of the most important aspects of the usage of mechanical ventilation. The mode refers to the method of aspiratory support. Mode selection is generally based on clinician familiarity and institutional preferences **(Esteban et al., 2001).**

Mechanical ventilation is one of the most commonly applied interventions in ICUs. Despite its lifesaving role, mechanical ventilation is associated with additional risks to the patient and additional health-care costs if not applied appropriately. Serious patient-ventilator dysynchrony is now known to frequently exist during all phases of breath delivery. Simply put, we classify the modes as one of either volume control, pressure control, or dual control.

Adaptive support ventilation (ASV) is a newly developed dual control mode, using measured dynamic compliance and time constant, with an automated adjustment of tidal volume and respiratory rate to meet the preset minute ventilation. ASV is based on the minimal Work Of Breathing which suggests that the patient will breathe at a VT and respiratory frequency (f) that minimizes the elastic and resistive loads while maintaining oxygenation and acid-base balance. **(Macintyre et al.,2006)**

Adaptive support ventilation (ASV) is a microprocessor-controlled mode based on pressure-controlled(PCV) and pressure-support(PS)ventilation ,with an automatic adaptation of respiratory rate and level of pressure to patient passive and active respiratory mechanics**(Tassaux et al.,2002).**

ASV was introduced in 1994 as an "electronic ventilator protocol" that incorporates measurements of respiratory mechanics and algorithms of closed-loop pressure control to maintain a target minute ventilation

The ASV algorithm uses Otis formula, along with patient weight (which determines dead space), to adjust several ventilation variables. The clinician enters the patient's ideal body weight; sets the high pressure limit, PEEP, and fraction of inspired oxygen (FIO2) **(Cambell et al., 2001).**

ASV has the capability to adjust automatically to the patients ventilatory requirements by selecting different VT–RR combinations based on respiratory mechanics in passive, mechanically ventilated patients and hence can be successfully applied to any subset of patients. The improved respiratory mechanics allow early weaning from mechanical ventilation **(Christopher et al., 2001).**

Aim Of The Work

The essay is concerned with discussion of the different modes of mechanical ventilation with special concern on adaptive supportive ventilation(ASV) as relatively one of the new modes of mechanical ventilation .

The essay entails explanation of the mechanism of action of ASV and enumeration of the advantages of this special mode over other modes specially its role in early weaning from mechanical ventilation.

Anatomy of airways

The respiratory tract begins at the anterior nares (nostrils) and the oral lips and ends in the alveoli of the lungs. It is divided into an upper and lower airway at the level of the vocal cords. **(Peterson et al., 2005).**

The upper airway

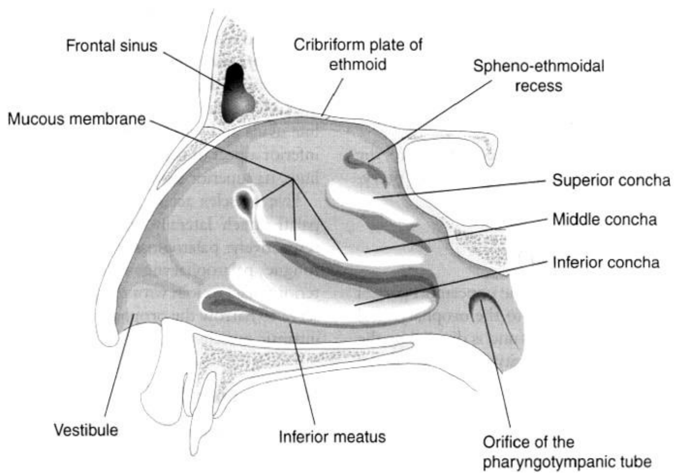
The Mouth

The mouth is made up of the vestibule and the mouth cavity, the former communicating with the latter through the aperture of the mouth. The mucosa of the floor of the mouth between the tongue and mandible bears the median frenulum linguae, on either side of which are the orifices of the submandibular salivary glands.

The hard palate is made up of the palatine processes of the maxillae and the horizontal plates of the palatine bones. The soft palate hangs like a curtain suspended from the posterior edge of the hard palate. Its free border bears the uvula centrally and blends on either side with the pharyngeal wall. Paralysis of the palatine muscles results (just as surely as a severe degree of cleft palate deformity) in a typical nasal speech and in regurgitation of food through the nose**(Ellis et al., 2004)**.

The nose and nasal cavity

The nasal airway extends from the anterior nares (nostrils) to the posterior nares (or choanae) before the nasopharynx. The nose itself contains the two nasal vestibules, each approximately 2 cm long and 1 cm wide, and leads to a nasal cavity. Its surface area is increased by three horizontally running bony folds: the superior, middle and inferior conchae (turbinates)**(Alan et al.,2001)**.



(Figure 1-1):- Sagittal section of the nose and nasal cavity**(Alan et al.,2001)**.

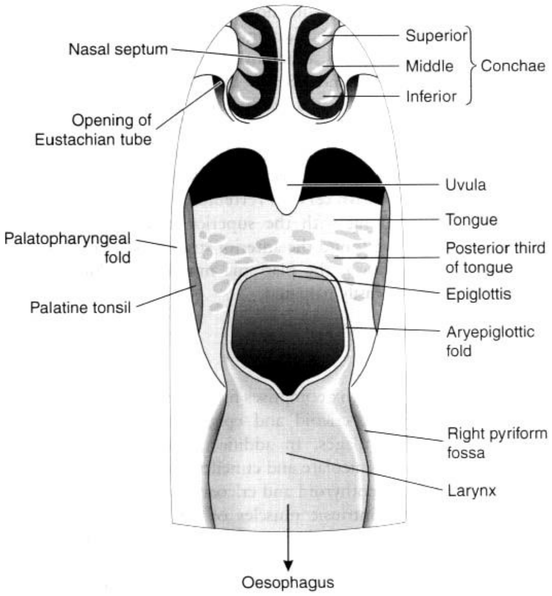
The pharynx

The pharynx is a fibromuscular tube at the 'crossroads' between mouth, nose, larynx and oesophagus. It extends from the skull base to the level of the sixth cervical vertebra, where it is in continuity with the oesophagus. The pharynx lies immediately anterior to the cervical spine and prevertebral fascia. The pharynx is divided into three parts: the nasopharynx, the oropharynx and the laryngopharynx.

The nasopharynx sits behind the posterior nares (choanae) and is in continuity with the oropharynx at the level of the soft palate. A Eustachian tube opens onto each lateral wall, and the posterior wall bears the pharyngeal tonsils (adenoids).

The oropharynx is in continuity below, with the laryngopharynx at the level of the tip of the epiglottis. Anteriorly it meets the oral cavity at the oropharyngeal isthmus formed by the palatoglossal folds. The lateral wall contains the palatine tonsil in its fossa between the palatoglossal and palatopharyngeal folds.

The laryngopharynx extends anterolaterally around the larynx towards the laminae of the thyroid cartilage. The two longitudinal channels thus created are termed the pyriform fossae and are a common site for impaction of foreign bodies. Each fossa is bounded anterolaterally by mucosa overlying thyroid cartilage, and medially by the aryepiglottic folds and cricoid cartilage**(McMinn .,1994).**



(Figure 1-2):- Coronal section of the pharynx showing the view of the posterior choanae, the oropharyngeal isthmus, the larynx and laryngeal inlet from behind**(McMinn, 1994).**

The larynx

The larynx separates the pharynx and trachea. It sits at the junction of the specialized airway and common airway and digestive tract and has evolved beyond a pure sphincter function. It has a skeleton made of cartilages, ligaments and membranes. In the adult male, the larynx is approximately 45 mm long and has an anteroposterior diameter of 35 mm. It is smaller in the adult female; 35 mm by25 mm. The larynx lies anterior to the proximal oesophagus in front of the third to sixth cervical vertebrae.

The skeleton of the larynx comprises five major cartilaginous components: the **thyroid, cricoid and epiglottic** cartilages and the paired **arytenoid** cartilages. In addition, there are two smaller paired bodies: the **corniculate and cuneiform** cartilages.