DIFFICULTY OF WEANING FROM MECHANICAL VENTILATION

Essay

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Intensive Care

By

Mohamed Maher El-Sha'arawi

M.B.B.Ch., EL-Mansoura University

Supervised by

Prof. Dr. Sahar Kamal Aboul Ella

Professor of Anaesthia, Intensive care& Pain Management
Faculty of Medicine-Ain Shams University

Prof. Dr. Noha Sayed Hussein

Professor of Anaesthia, Intensive care& Pain Management
Faculty of Medicine-Ain Shams University

Dr. Wael Sayed Abd El Ghaffar

Lecturer of Anaesthia, Intensive care& Pain Management
Faculty of Medicine-Ain Shams University

Faculty of Medicine
Ain Shams University
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Mohamed Maher El-Sharawi

Contents

List of Abbreviations

ACV	:	Airway pressure patterns in assist-control ventilation
ACV	:	Assist-control ventilation
APRV	:	Airway pressure release ventilation
ARDS	:	Acute respiratory distress syndrome
BAL	:	Bronchoalveolar lavage
BiPAP	:	Bilevel positive airway pressure
CMV	:	Conventional mechanical ventilation
COPD	:	Chronic obstructive pulmonary disease
CPAP	:	Continuous positive airway pressure
2, 3 DPG	:	2,3 Diphosphoglycerate
ERV	:	Expiratory reserve volume
FEV	:	Forced expiratory volume
FRC	:	Functional residual capacity
FVC	:	Forced vital capacity
HFOV	:	High frequency oscillatory ventilation
IMV	:	Intermittent Mandatory Ventilation

List of Abbreviations (Cont.)

IRV	:	Inverse ratio ventilation
NHSN	:	National Healthcare Safety Network
NAC	:	Mucolytic Therapy with N-acetylcysteine
NIV	:	Noninvasive ventilation
PCV	:	Pressure-Controlled Ventilation
PEEP	:	Positive end-expiratory pressure
PRVC	:	Pressure- regulated, volume control
PSB	:	Protected specimen brush
PSV	:	Pressure-Support Ventilation
RV	:	Residual volume
SBT	:	Spontaneous breathing trial
SDD	:	Selective digestive decontamination
SOD	:	Selective oral decontamination
VAP	:	Ventilator associated pneumonia
VCV	:	Volume-controlled ventilation
VILI	:	Ventilator induced lung injury
TLC	:	Total lung capacity

List of tables

List of Figures

List of Figures (Cont.)

Introduction

Mechanical ventilation is a common life support modality in ICUs. The process of ventilatory support follows a continuum of care, beginning with the patient requiring initial support and hopefully ending with the ability to sustain spontaneous breathing ***(Hass & Loik 2012)***.

Weaning from mechanical ventilation requires dynamic and collaborative decision making to minimize complications and avoid delays in the transition to extubation and effective collaboration requires open, extensive, and coordinated communication as well as shared team goals and will result in improved quality of care, patient safety and discharge outcomes ***(Rose et al., 2011).***

The process of discontinuing mechanical ventilatory support begins by recognizing that the patient has begun to recover from the problems that required ventilatory support. Criteria by which clinicians decide whether the patient has sufficiently recovered in order to tolerate the withdrawal of ventilatory support ***(Teixeira C et al., 2012).***

Patients are classified into 3 groups, according to the duration of weaning and the numbers of spontaneous breathing trials (SBTs) preceding successful extubation. simple weaning for patients successfully intubated after the first (SBT), difficult weaning for patients successfully extubated after 2 or 3 (SBTs), or weaning took less than 7 days from the first SBT to successful extubation & prolonged weaning if patient not weaned after 2 or 3 (SBTs) or weaning took more than 7 days ***(Tonnelier A et al., 2011).***

The most likely causes for failed weaning, with the understanding of the barriers that impede successful weaning

in a specific patient. The following topics should be evaluated in a difficult-to wean patient like airway and lung dysfunction, brain dysfunction, cardiac dysfunction, diaphragm dysfunction, and endocrine dysfunction ***(Heunks and van der Hoeven 2010).***

Rationale for Facilitating Weaning and Extubation was justified by the adverse outcomes associated with prolonged mechanical ventilation and extubation failure. Non-invasive ventilation NIV may facilitate early extubation in very selected patients who have failed weaning. Similarly, immediate application of NIV appears to prevent post-extubation respiratory distress in patients at high risk of extubation failure ***(Epstein S 2009).***

Aim of the work

Aim of this work is to discuss the causes of weaning difficulty and how can we overcome them.

Chapter (1)

Lung Anatomy

Overview

The anatomy of the respiratory system can be divided into 2 major parts, airway anatomy& lung anatomy. Airway anatomy can be further divided into the extrathorathic (superior) airway, which includes the supraglottic, glottic, and infraglottic regions, and the infrathorathic (inferior) airway, which includes the trachea, the mainstem bronchi, and multiple bronchial generations (which conducts air to alveolar surface). Lung anatomy includes the lung parenchyma, which carries parts of the conducting system but is mainly involved in the gas exchange at the alveolar level. The lung parenchyma is further subdivided into lobes& segments ***(Adams et al., 2010).***

Gross anatomy

1- Trachea

The trahea is a cartilaginous & fibromuscular tube that extend from inferior aspect of the cricoid cartilage (six cervical vertebra level) to the main carina (fifth thorathic vertebra level). Length is about3 cm at birth and 10-12 cm in adults (of which 2-4 cm is extrathorathic& 6-9 cm intrathorathic). Diameter varies widely, ranging from13-25 mm in male and 10-21 mm in female. Tracheal wall has 4 different layers includes, mucosa, submucosa, cartilage/muscle, and adventitia. Posterior wall lacks cartilage& instead is supported by thin band of smooth muscle. Shape of trachea changes during expiration due to invagination of the posterior wall causing as much as 30%

reduction in the antero-posterior diameter ***(Harjeet et al.,2008).***

Microscopic anatomy: The trachea has multiple layers, the mucosa is composed of a ciliated pseudostratified columnar epithelium and numerous mucus-secreting goblet cells that rest on a basement membrane with a thin lamina propria (mainly cartilaginous).The submucosa which contains seromucous glands. The adventitia contains hyaline cartilaginous rings interconnected by connective tissue, these rings are C-shaped and are opened posteriorly. The open ends are connected by fibroelastic tissue and a band of small muscle (the trachealis) ***(Mescher AL, 2009).***

2- Bronchi

The airways are divided by dichotomous branching, with approximately 23 generations of branches from the trachea to alveoli. Bronchi are composed of cartilaginous and fibromuscular elements; however, the distinction between these elements is less clear-cut in the bronchi than in the trachea especially in the more distal airways. Wall thickness is approximately proportional to the airway diameter on airways distal to the segmental branches. For airways less than 5 mm in diameter, the wall should measure 1/6 to 1/10 of the diameter. Different nomenclatures have been applied to the bronchial tree over years. Generally, there are 2 mainstem bronchi (right and left). The right has 3 lobar bronchi, with a total of 10 segmental bronchi, while the left: 2 lobar bronchi, with a total of 8 segmental bronchi. No accepted terminology of the subsegmental bronchi exists. The Terminal bronchioles, including (respiratory bronchioles, alveolar ducts & sacs) ***(Adams et al.,2010).***

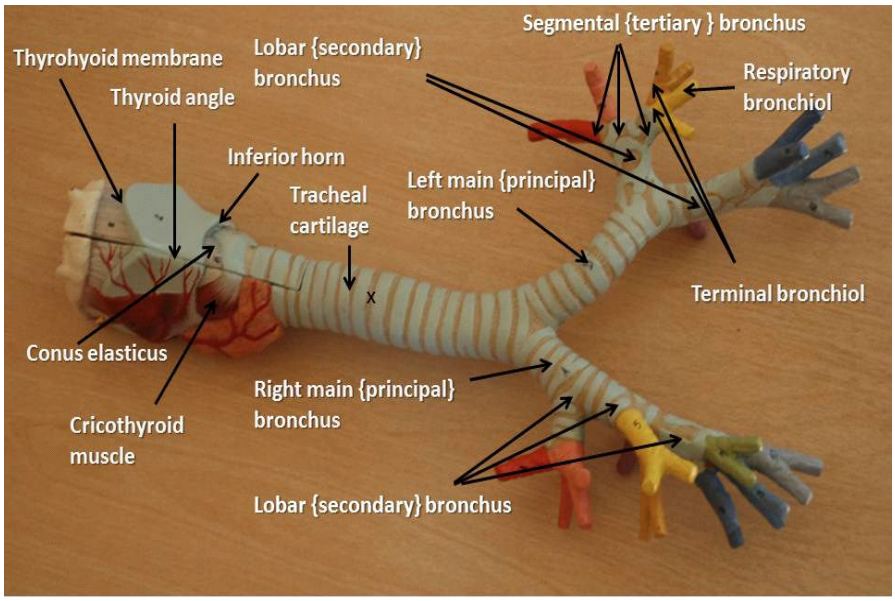

Fig. (1) Tracheobronchial tree ***(Ferguson MK, 2010).***

Microscopic anatomy: The terminal bronchioles are considered the respiratory zone of the lung (area where gas exchange occurs). They divided into respiratory bronchioles, which continue downstream as alveolar ducts and alveolar sacs. Over 300 million alveoli exist in the human lung, all of them are covered by extensive network of capillaries. The epithelium of the respiratory bronchioles is primary cubiodal and may be ciliated; goblet cells are absent. Alveoli appear as small pockets that interrupt the main wall. The terminal portion of the respiratory duct gives rise to alveolar sac (composed of a variable number of alveoli). The interalveolar septum often contains 10-15 micrometer openings between neighboring alveoli that help equalize air pressure among them. The alveolar wall is very thin (25 nm) and formed by squamous epithelium (type 1 cells) covered by a thin film of surfactant fluid rich in hydrophilic phospholipid produced by type II cells (septal cells) ***(Mescher AL, 2009).***