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AnestheticConsiderations of Pediatric Patients with Co-Existing Common Respiratory Diseases

Essay
Submitted for Partial Fulfillment of Master Degree in Anesthesiology

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ
ورَسُولُهُ والْمُؤْمِنُونَ

صدق الله العظيم

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List of Abbreviations

ACQ	:	Asthma Control Questionnaire
ACT	:	Asthma Control Test
AHR	:	Airway hyper- responsiveness
BPD	:	Bronchopulmonary dysplasia
cAMP	:	Cyclic adenosine monophosphate
CF	:	Cystic fibrosis
CFTR	:	Cystic Fibrosis transmembrane conductance regulator
CPA	:	Continuous positive airway pressure
CT	:	Computerized tomography
DNA	:	Deoxyribonucleic acid
ETT	:	Endotracheal tube
FEV_1	:	Forced expiratory volume in 1 s
FiO_2	:	Fraction of inspired oxygen
FRC	:	Functional residual capacity
GINA	:	Global Initiative for Asthma
ICU	:	Intensive care unit
IgG	:	Immunoglobulin G
IL	:	Interleukin
LMA	:	Laryngeal mask airway
MDI	:	Metered dose inhaler
MRI	:	Magnetic Resonance Imaging
MRSA	:	Methicillin Resistant Staphylococcus Aureus
NE	:	Neutrophil elastase
NSAIDs	:	Nonsteroidal antiinflammatory drugs
PE	:	Pulmonary edema
PFTs	:	Pulmonary function tests
PIE	:	Pulmonary interstitial emphysema

List of Abbreviations(Cont.)

PPV	:	Positive-pressure ventilation
PRAEs	:	Perioperative respiratory adverse events
RDS	:	Respiratory distress syndrome
RSV	:	Respiratory syncytial virus
RV	:	Residual volume
TIVA	:	Total intravenous anesthesia
TLC	:	Total lung capacity
URI	:	Upper respiratory infection
URTI	:	Upper respiratory infection

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Introduction

Respiratory events are a major risk for perioperative morbidity and may cause up to 30% of perioperative cardiac arrests in children***(Bhananker et al., 2007).***

Maintaining oxygenation and carbon dioxide exchange is a fundamental component of anesthesia practice. Anesthesiologists frequently encounter children with co-existing pulmonary disease during preoperative assessments, intraoperative, or in intensive care units. Their illnesses encompass a wide spectrum of disease ranging from mild upper respiratory tract infections to chronic lung disease and end-stage pulmonary failure***(Lauer et al., 2012).***

Pediatric chronic lung diseases may include bronchiectasis, interstitial pulmonary fibrosis, broncho-pulmonary dysplasia, bronchiolitis obliterans, sequestrated lung disease, bronchial asthma and cystic fibrosis. They can be primary or secondary, congenital or acquired (***Ibrahim et al., 2011***).

Asthma and bronchopulmonary dysplasia (BPD) are two of the most common pulmonary disorders encountered by pediatric anesthesiologists. The prevalence of asthma is increasing. A common squeal of preterm birth is BPD, which is associated with persistent airway disease and, in severe cases, pulmonary hypertension that increase perioperative morbidity.

These diseases share the physiology of bronchoconstriction and variably decreased flow in the airways, but also have unique physiological consequences. The anesthesiologists can make a difference in outcomes with proper preoperative evaluation and appropriate preparation for surgery in the context of a team approach to perioperative care with implementation of a stepwise approach to disease management. An understanding of the importance of minimizing the risk for bronchoconstriction

and having the tools at hand to treat it when necessary is paramount in the care of these patients. Unique challenges exist in the management of pulmonary hypertension in BPD patients***(Lauer et al., 2012)***.

Cystic fibrosis (CF) is the most common, lethal genetic disease in Caucasians***(Fitzgerald & Ryan, 2011)***. It is a multisystem disorder, with the respiratory system most commonly affected**.** The viscid mucous secretions and decreased mucociliary clearance seen in CF lead to patchy atelectasis, airway inflammation, and chronic hypoxia. With time, airway obstruction occurs, with air trapping and development of bronchiectasis.

Patients with respiratory disease may either follow a relapse–remit pattern with return to baseline function between exacerbations or may experience a steady decline in lung function, with eventual development of cor-pulmonale, respiratory failure, and death***(Moran et al., 2009).***

One of the most controversial issues in pediatric anesthesia has revolved around the decision to proceed with anesthesia and surgery for the child who presents with an upper respiratory tract infection (URI). In the past, medical practice dictated that children with URIs have their surgery postponed until the child was symptom free. This practice was based on the empirically supported premise that anesthesia increased the risk of serious complications and complicated the child's postoperative course. Although recent clinical data confirm that some children with URIs are at increased risk of perioperative complications, these complications can, for the most part, be anticipated, recognized, and treated. Although the child with a URI still presents a challenge, anesthesiologists are now in a better position to make informed decisions regarding the assessment and management of these children, such that blanket cancellation has now become a thing of the past***(Tait et al., 2005).***

Aim of the Work

The aim of the present work will be to review the anesthetic plan for pediatric patients with co-existing pulmonary diseases in order to prevent or reduce the incidence of perioperative complications.

We will review the most common pediatric respiratory diseases whether acute or chronic. Furthermore we will discuss the pathophysiology of the most common respiratory diseases in pediatrics. On the other hand, we will review the recent literatures and the previous studies to clarify how we can use the understanding of those diseases to prevent and manage perioperative complications.

Chapter 1

Pediatric Respiratory System: Anatomy and Physiology

The respiratory system is comprised of several elements including the central nervous system, the chest wall, the pulmonary circulation, and the respiratory tract. The respiratory tract can be divided into four distinct segments: the naso-oropharynx, the conducting airways, the respiratory bronchioles, and the alveoli***(Seeley et al., 2006)***.

In humans, respiration takes place in the respiratory organs called lungs. The passage of air into the lungs to supply the body with oxygen is known as inhalation, and the passage of air out of the lungs to expel carbon dioxide is known as exhalation; this process is calledbreathingorventilation. Molecules of oxygen and carbon dioxide are passively exchanged, by diffusion, between the gaseous external environment and the blood. This exchange process occurs in the alveoli(air sacs) in the lungs***(Maton et al., 2010)***

Anatomy ofthe respiratory system & anatomical differences in pediatrics:

The respiratory tract (figure 1) starts with the naso-oropharynx, which begins with the nostrils, lips, including the nasal passages, sinuses, and glottis until reaching the trachea then into the lungs.The lungs can be divided into the conducting airways and the units of respiration The trachea, bronchi, and bronchioles conduct and transport air from the outside world and deliver it to the respiratory units—the

alveoli. Gas exchange occurs at the level of the alveoli, providing the necessary oxygen for the body's daily functions***(Kochar, 2002)***.

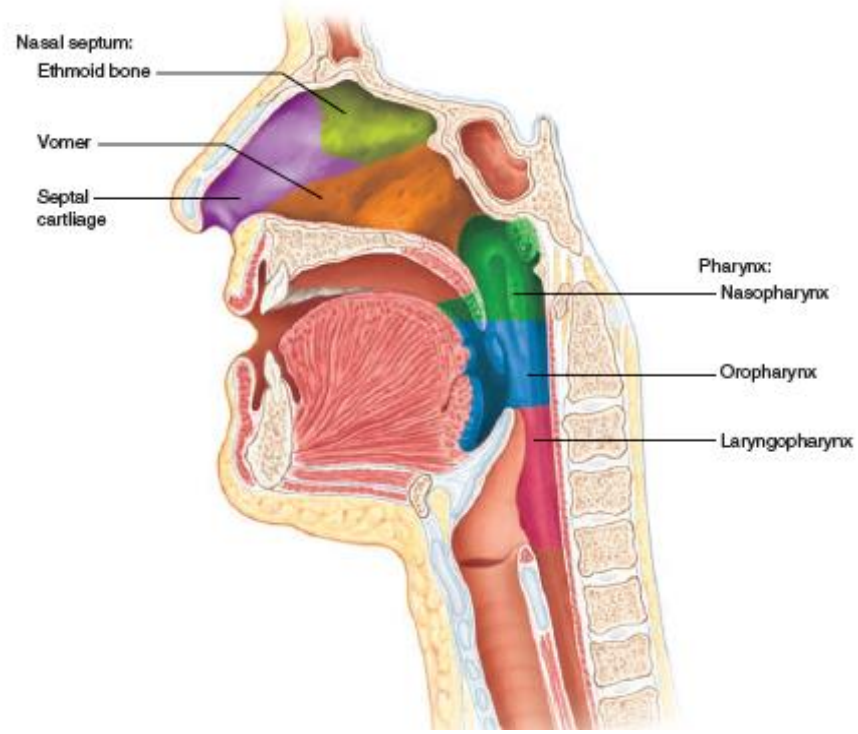

Figure (1): The upper respiratory system***(Kochar, 2002)***.

The first segment of the respiratory tract is the naso-oropharynx, which begins with the nostrils and lips, and includes the nasal passage, sinuses, and glottis until reaching the trachea. The purpose of the naso-oropharynx is to filter out any large particles and to humidify and warm the air that is delivered to the respiratory units***(Kochar, 2002)***.

The larynx (figure 2, 3) is a cartilage box (voice box) of nine separate cartilages, eight of which are composed of hyaline cartilage connective tissue. The epiglottis (the ninth cartilage of the larynx) is composed of elastic cartilage connective tissue. The epiglottis stands almost vertically over

the glottis. The epiglottis and muscles of the larynx coordinate the passage of food and air, and generally assure that food reaches the esophagus and air reaches the trachea***(Reynolds, 2004)***.

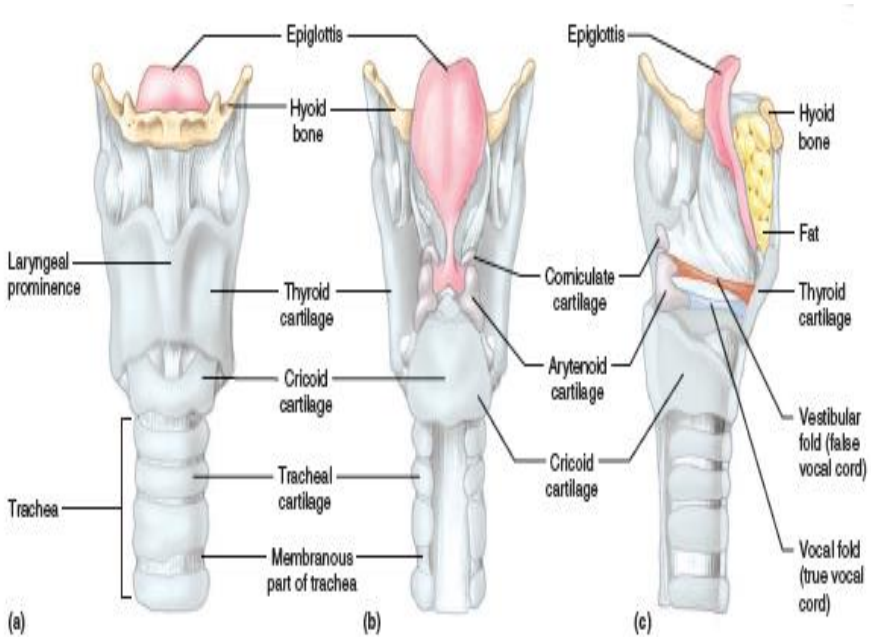

Figure (2): The larynx***(Shier et al., 2010).***

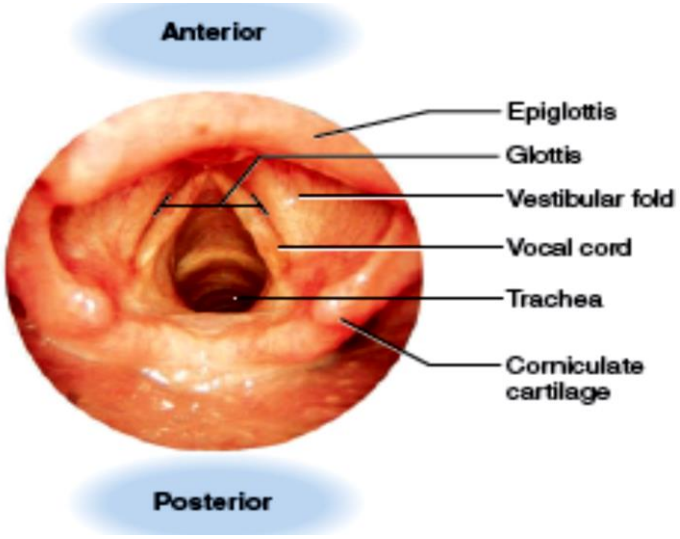

Figure (3): The Vocal cord***(Shier et al., 2010).***

The next segment is the conducting airways, beginning with the trachea, which branches repeatedly to form approximately 14 generations of conduits for air reaching several distinct pulmonary segments. The trachea bifurcates at the carina into the right and left main stem bronchi. Aspiration occurs more commonly at the right main bronchus because of its gentler angle off the trachea***(Seeley et al., 2006).***

From the larynx, inspired air travels to the trachea, a rigid tube with 18 to 20 C-shaped cartilages composed of hyaline cartilage connective tissue. These cartilages hold the trachea open for the easy flow of air. The C-shaped cartilages are open posterior with smooth muscle bridging the gap***(Kochar, 2002).***

The right lung (figure 4) is divided into upper, middle, and lower lobes, each of which is further subdivided into segments and each with its own conducting airway***(Reynolds, 2004)***.

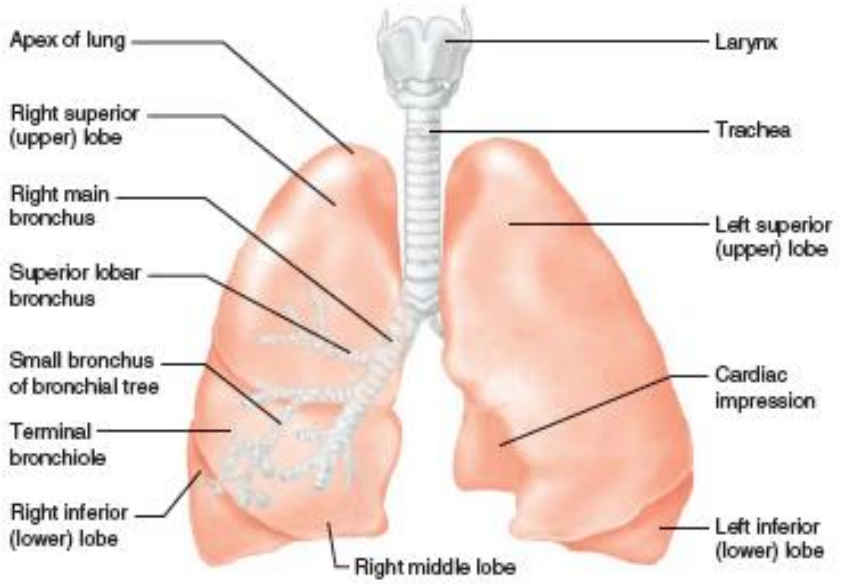

Figure (4): Gross anatomy of the lungs and bronchial tree***(Seeley et al., 2006).***