Clinical physiology of the respiratory system II

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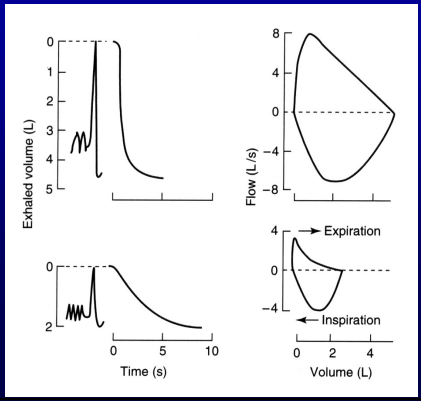
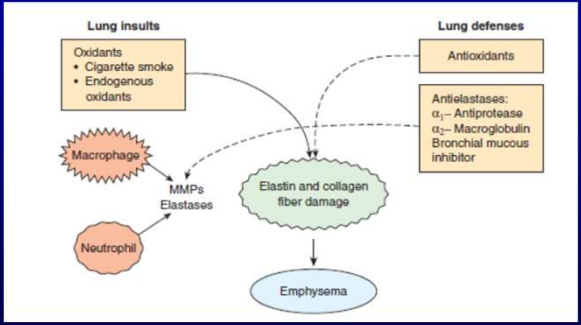
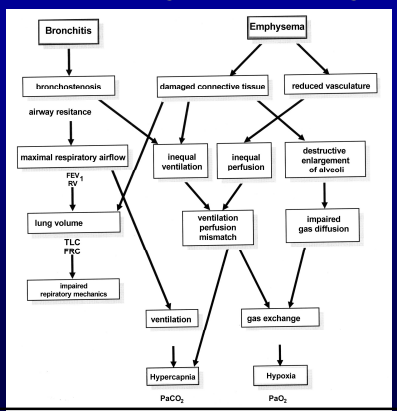
Signs of obstructive respiratory disorders



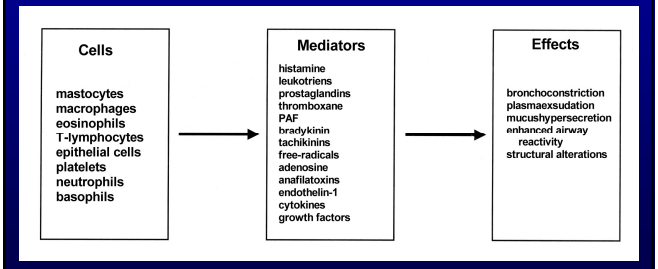
Pathomechanism of emphysema (extrabronchial obstructive disorder)



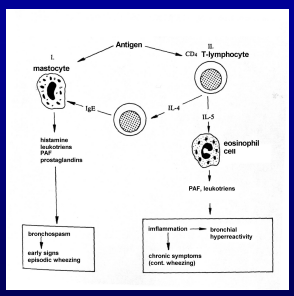
Why do obstructive disorders lead to respiratory insufficiency?



Mechanisms leading to intrabronchial obstruction during bronchial asthma

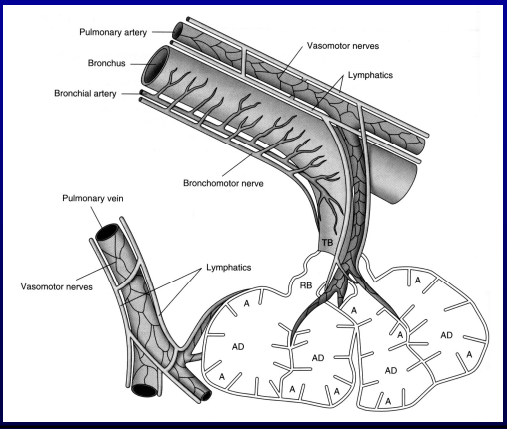


Acute and chronic phases during bronchial asthma



Asthma: Cellular inflammatory events.
Epithelial cell activation or injury
Cytokine (IL-8) and chemokine release, with neutrophil chemotaxis or activation
Antigen presentation to lymphocytes
Secretory epithelial cell hyperplasia and hypersecretion
Epithelial death; increased magnitude of airway sensory neural reflexes
Lymphocyte activation
Antigen exposure with lymphocyte proliferation
Increased cytokine and chemokine expression; activation of additional effector cells (dendritic cells, mast cells, eosinophils, macrophages)
Activation of B cells; increased IgE synthesis
Augmented lymphocyte activation by local cytokines
Mast cell and eosinophil activation
Eosinophil release of cytotoxic and acute proinflammatory mediators
IgE-mediated mast cell activation, with acute mediator release (eg, histamine, leukotrienes, platelets activating factor)
New expression of multiple cytokines by mast cells, with multiple effector cell activation, as with lymphocytes

Smooth muscles in bronchi and in vessel walls



Diameter changes in the bronchial system

Lateral traction: an increase in diameter when lung volume increases and vice a versa

Bronchial smooth muscle cells :

parasympathetic nerves: Ach, M_3-receptors:
contraction -> bronchoconstriction

sympathetic nerves: EPI, β_2-receptors:
relaxation -> bronchodilation

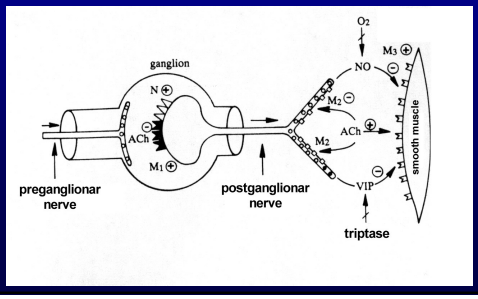
Nor-EPI, α_1-receptors:
contraction -> bronchoconstriction

Nonadrenergic noncholinergic system (co-transmitters of the autonomic nerves)

PS: VIP, Substance P, CGRP
SY: neuropeptid-Y,
OTHER: ATP, NO
relaxation -> bronchodilation

Control over bronchial smooth muscle activity through muscarinic receptors

M3: postsynaptic –> bronchoconstriction
M2: presynaptic -> Ach release inhib. -> bronchodilation
M1: preganglionic -> bronchoconstriction



Diameter changes in the pulmonary vascular system

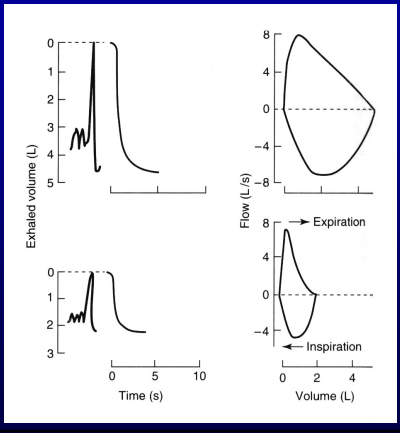
Vascular smooth muscle cells :

sympathetic nerves, Nor-EPI, α_1-receptors
Contraction -> vasoconstriction

Nonadrenergic noncholinergic system, ATP, NO, Substance P, VIP,
Dilation -> vasodilation

Alveolar $PO_2 \downarrow$ -> vasoconstriction
(important in ventilation perfusion matching)

Signs of restrictive respiratory disorders



Restrictive respiratory disorders

TLC reduced, pathologic low lung compliance

1. Reduced respiratory surface:
   a./ interstitial lung diseases (eg. infections, fibrosis, tumor, etc.)
   b./ pneumothorax, resection, congestion, edema

2. Impaired respiratory movements:
   a./ Abnormalities of the thoracic cage (deformities, Bechterew disease, abnormalities of the pleura, obesity)
   b./ neuromuscular diseases (myasthenia gravis, myopathies, etc.)

Clinical definitions for respiratory insufficiency

Type I (hypoxaemic, non-ventilatory, partial)

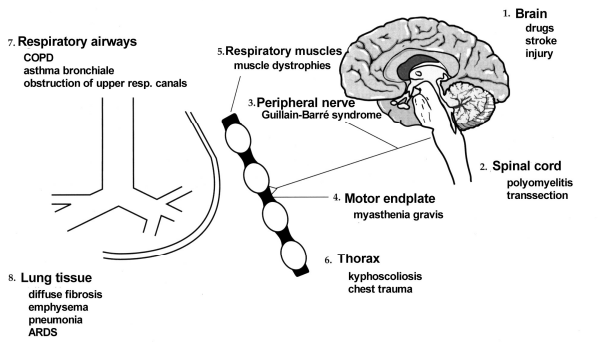
destructed lung parenchyme
ventilation-perfusion mismatch, (e.g. COPD, (only during exercise))
right-left shunt eg. atelectasis, alveolar inflammation, ARDS, cardiogenic edema)

$P_{art}O_2$ < 60 mmHg
$P_{art}CO_2$ =< 40 mmHg

Type II (hypoxaemic-hypercapnic, ventilatory, global)
alveolar hypoventilation

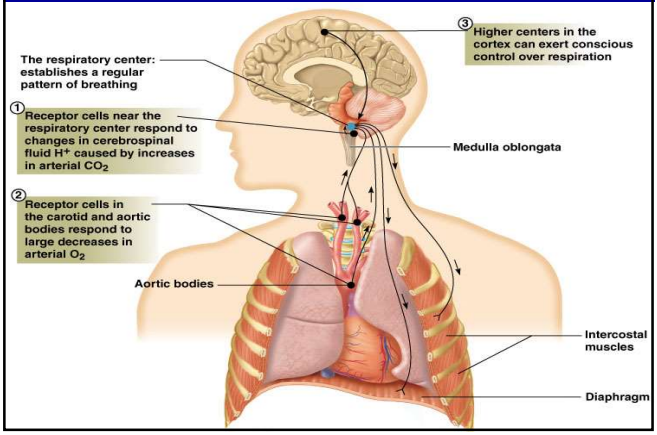
$P_{art}O_2$ < 60 mmHg
$P_{art}CO_2$ > 50 mmHg
pH: acidotic

Possible causes of respiratory insufficiency



Causes of respiratory insufficiency

Regulation of Breathing

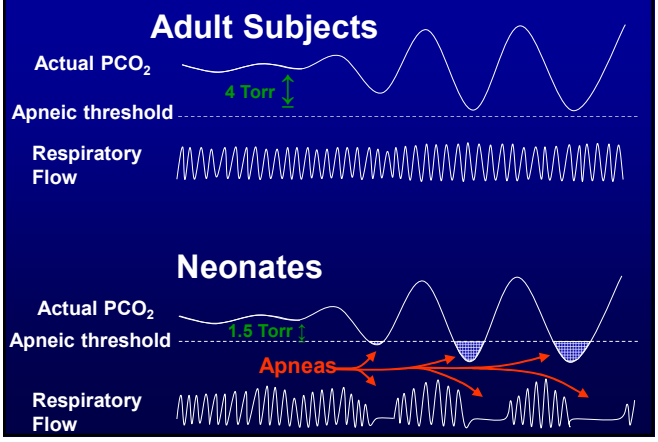


Pathologic breathing patterns

Breathing patterns

Pattern	Condition	Description
	Eupnoea	Normal breathing rate and pattern
	Tachypnoea	Increased respiratory rate
	Bradypnoea	Decreased respiratory rate
	Apnoea	Absence of breathing
	Hyperpnoea	Increased depth and rate of breathing
	Cheyne-Stokes	Gradual increases and decreases in respirations with periods of apnoea
	Biot's	Abnormal breathing pattern with groups/clusters of rapid respiration of equal depth and regular apnoea periods
	Kussmaul's	Tachypnoea and hyperpnoea
	Apneustic	Prolonged inspiratory phase with a prolonged expiratory phase

Explanation for periodic breathing



Pathologic Apnea:
respiratory pause ≥ 20 s or any pause associated with bradycardia or significant desaturation