The Effects of Aging on the Cardiopulmonary System

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بسم الله الرحمن الرحيم
(الله الذي خلقكم من ضعف ثم جعل من بعد ضعف قوة ثم
جعل من بعد قوة ضعفا وشيبة يخلق ما يشاء وهو العليم
القدير)
سورة الروم الاية ٥٤

What is Aging?

Why do we age?

Theories

Cellular theories

- Limited number of times a cell can divide
- Cross- linking
  - Tissue become stiffer with age
- Free radicals
  - Reactive chemicals causing cellular damage

DEFINITION OF AGING

The process of growing old, especially by failure of replacement of cells in sufficient number to maintain full functional capacity.

- Chronological age - number of years lived
- Physiologic age - age by body function
- Functional age - ability to contribute to society

CHRONOLOGICAL CATEGORIES

- Chronologic age is not an accurate predictor of physical condition or behavior”
- **Young-Old - (ages 65 - 74)**
- **Middle-Old - (ages 75 - 84)**
- **Old-Old - (age 85 and older)**

PHYSIOLOGICAL THEORIES OF AGING

What causes the body to age?

Most biologists define aging as an age-dependent or age-progressive decline in intrinsic physiological function, leading to an increase in age-specific mortality rate.

Normal aging is influenced by

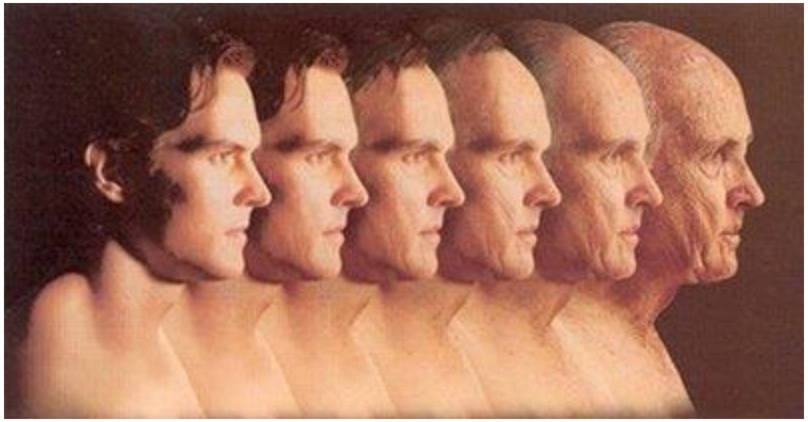
- Genetics
- Socioeconomics

- Lifestyle
- Physiology

Physiologic, psychological and Pathologic Age-Related Changes

Irreversible changes in the function of most organs can be shown to occur by the third and fourth decades of life, with progressive deterioration with age.

-Normal aging affects all physiological process.

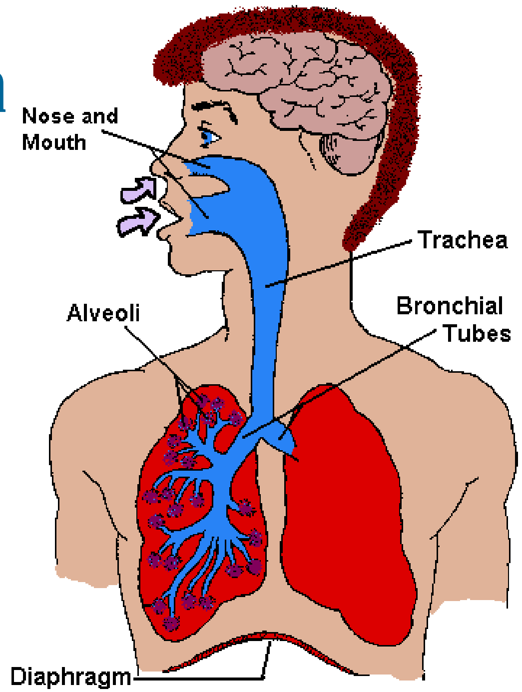


Physiology of the ageing lung

- Everyone needs to breathe!
- Limitation of knowledge
- Many respiratory studies don’t include the older patient esp after the age of 80
- Is “ageing of the lung” intrinsic or extrinsic?
- Ageing may influence response to, and treatment of lung disease

Influence of Aging on the Respiratory System

- Most of the pulmonary function indices reach their maximum levels between 20 and 25 years of age and then progressively decline.
- The precise influence of aging on respiratory system is difficult to determine.



Major changes in lung physiology with age *Intrinsic ageing

Reduced
- Lung elasticity
- **Respiratory muscle strength**
- **Chest wall compliance**
- **FEV1 (declines before FVC)**
- Bronchial hyper-responsiveness
- **Perception of bronchoconstriction**
- Diffusion capacity
- Arterial oxygen pressure and saturation
- **Ventilatory response to hypoxia and (more worryingly) hypercapnia**

Increased
- Residual volume
- Lung compliance
- Oxygen uptake on exercise

Unchanged
- Total lung capacity
- Airways resistance
- Pulmonary arterial resistance
- Arterial CO2 levels

*Extrinsic lung ageing

Factors identified in age

- Tobacco smoking
- Occupational exposure
- Asthma
- Atopy
- Obesity
- Excessive alcohol consumption
- **Respiratory infection in early life**
- **Nutritional status at birth**
- **Maternal or passive smoking**

(NYSMOKEFREE.COM)

Normal Respiratory Changes Lungs:

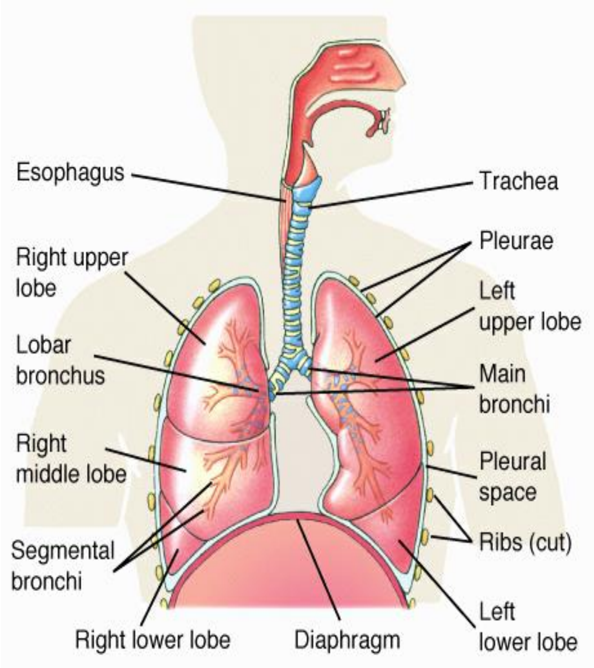
Anatomical changes

- Respiratory muscles atrophy & weaken
- Chest wall stiffens→ Less lung expansion
- A ⇑ rigidity of rib cage (calcification of costal cartilage)
- Respiratory fluids ⇓ 30% and ⇓ elastic recoil
- Reduction respiratory activity
- Kyphosis
- Increased anterior- posterior diameter of chest.

Normal Respiratory Changes Upper Airway:

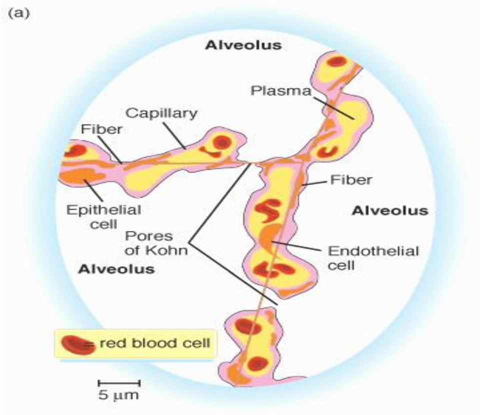
Anatomical changes

- Nose enlargement (from continued cartilage growth)
- Tonsilar atrophy
- Deviations in the trachea
- A ⇓ in effectiveness of cilia in tracheobronchial tract.



Normal Respiratory Changes Lungs:

<u>Anatomical changes:</u>

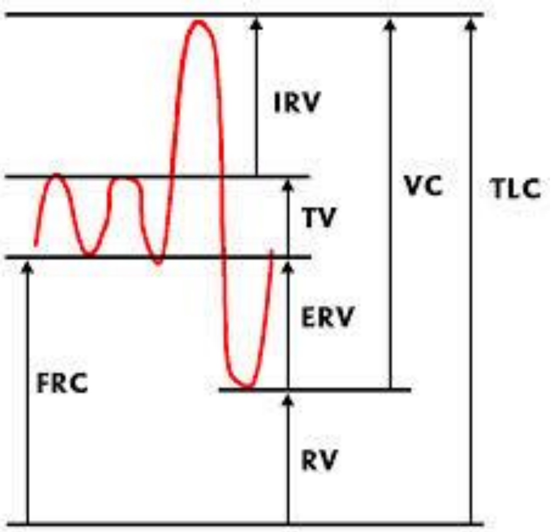


- A ⇓ elasticity of alveoli
- A ⇓ size of functioning alveoli
- This is paralleled by increasing rigidity of lung tissue and decreased force of expiration, so that **decreased capacity to cough** becomes an important clinical consideration.

Normal Respiratory Changes

Physiologic changes

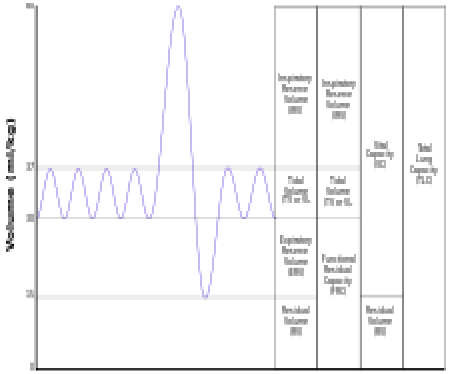
- A ⇓ vital capacity
- A ⇓ cough reflex
- A ⇓ breathing efficiency
- A ⇓ O_2 carrying capacity of blood
- A ⇓ inspiratory & expiratory forces



Normal Respiratory Changes

Physiologic changes (cont'd)

- A ⇓ surface area for gas exchange
- A ⇓ arterial partial pressures of oxygen
- A ⇓ responsiveness to hypoxemia & hypercapnia
- A ⇑ respiratory rate to 16-25 / min
- A ⇓ TV and minute ventilation



Normal Respiratory Changes

Functional Implications

- Breathing patterns are more dependent upon intra-abdominal pressure changes
- Breathlessness at low exercise levels
- A ⇑ breathing effort under stress
- Muscle de-conditioning

Normal Respiratory Changes

<u>Functional Implications</u> (cont'd)

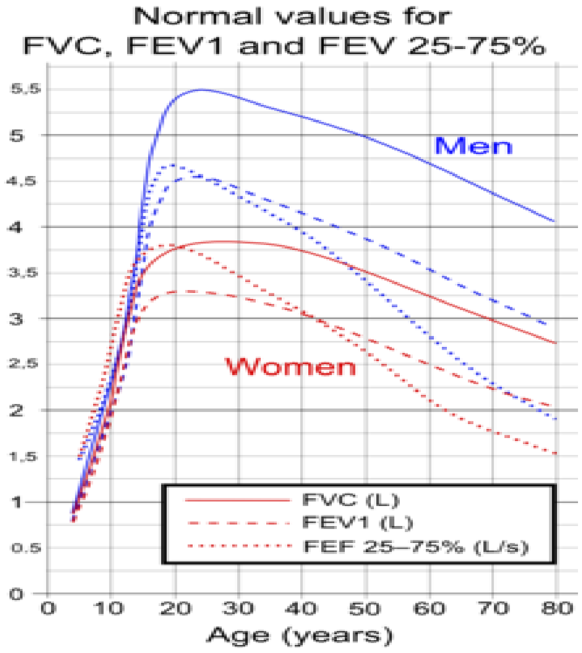
- A ⇓ ability to clear secretions
- A ⇑ susceptibility to infection
- A ⇑ risk of aspiration
- Snoring

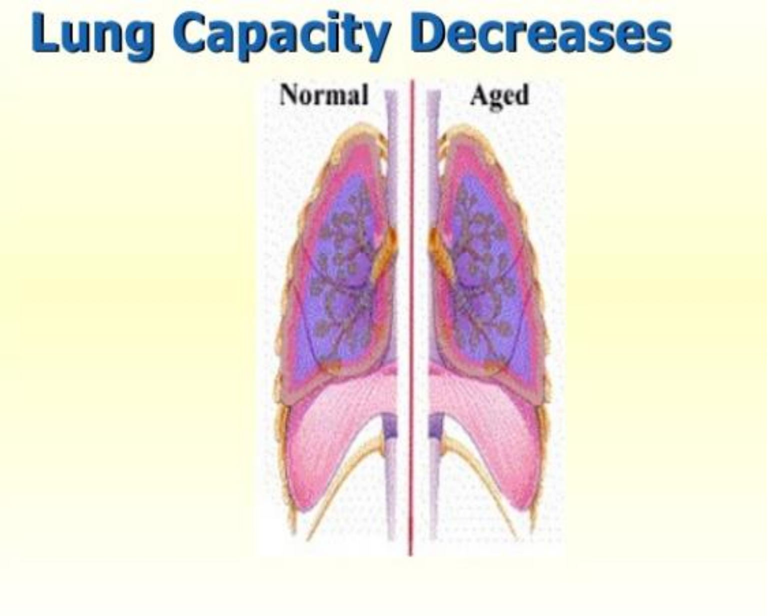
- Little change in resting respiratory function

- Decrease capacity to perform physical activity
- metabolic (muscle) ? Decreas
  - Muscle mass
  - Muscle strength
  - Muscle power
  - Muscle contraction velocity
  - Muscle mitochondrial function
  - Muscle oxidative enzyme capacit
- Cardiovascular ?
- Respiratory ?
- All play a role

A liner **decrease of vital capacity**

Is found that amounts to a decrement of about 26 ml /year for men and 22 ml / year for women starting at age 20.

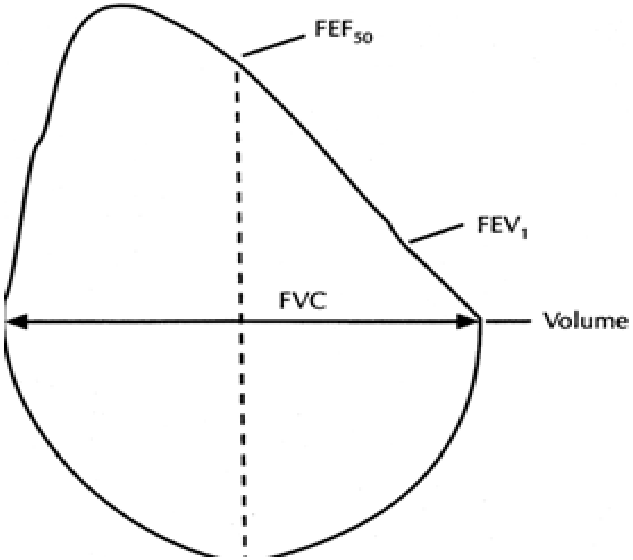




Whereas, in the young the basal portion of the lung is the best ventilated, the upper lobes and apices ventilate best in the elderly, causing relative **basal collapse**, and disturbing the normal relationship between ventilation and perfusion.

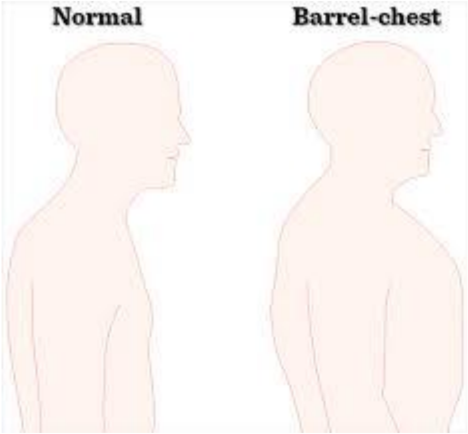
Which result in progressive **decrease of arterial oxygen pressure** with age.

- There is a **20% to 30% decrease** in maximum voluntary ventilation, forced expiratory volume in one second, maximal expiratory flow rate and maximum mid expiratory flow during adult life.
- These changes may relate to a decrease in the elastic recoil properties of the lung.



Static Mechanical Properties

- With aging, the elastic recoil of the lungs decreases, causing lung compliance to increase.
- The decrease in lung elasticity develops because the alveoli progressively deteriorate and enlarge after age 30.
- Structurally, the alveolar changes resemble the air sac changes associated with emphysema.

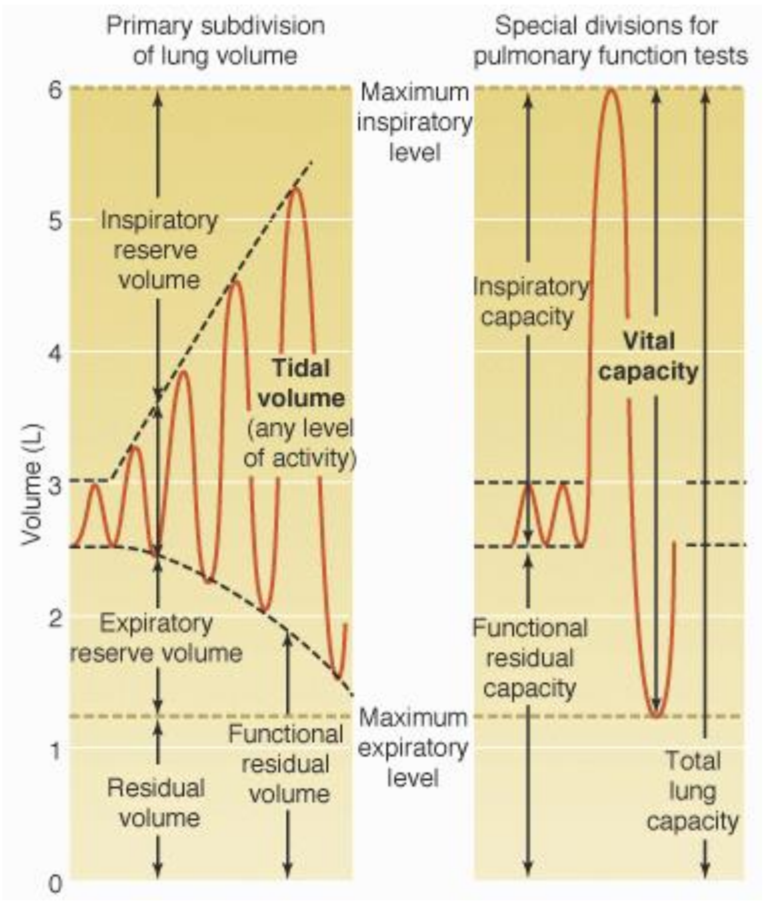


Static Mechanical Properties

- With aging the costal cartilage of the thoracic wall progressively calcify, and causes a structural change in which the thorax becomes less compliant.
- The reduction in chest wall compliance is slightly greater than the increase in lung compliance, resulting in an overall moderate decline in total compliance of the respiratory system.

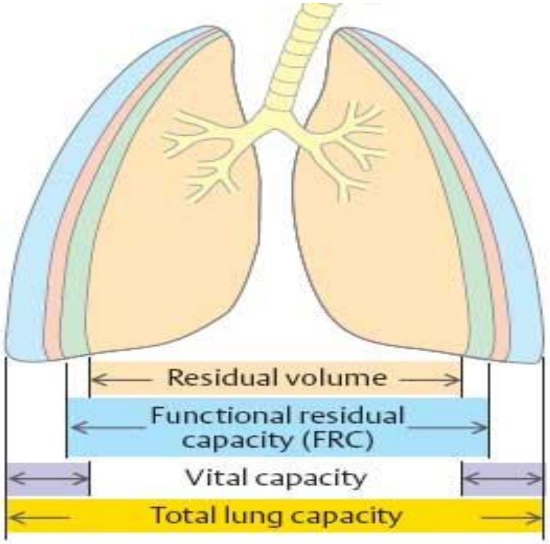
Volume and Capacity Changes

- It is common to see a drop in TLC with aging due to the decreased height associated with aging.
- Residual volume tends too increase with age due to age-related alveolar enlargement and small airway closure.
- Since the RV increases, the FRC also increases and forces the inspiratory capacity to decrease.



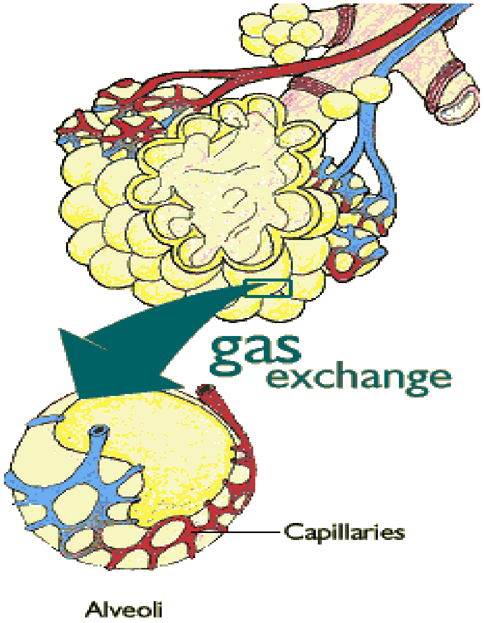
Dynamic Maneuvers and Aging

- Dynamic maneuvers refer to flow rates during ventilation.
- Due to the loss of lung elasticity associated with aging, there is a reduced efficiency in forced air expulsion.



Diffusion Capacity and Aging

- The pulmonary diffusion capacity progressively decreases with age.
- It is estimated that the DLCO falls about 20% over the course of adult life.
- This is probably the result of decreased alveolar surface area and decreased pulmonary capillary blood flow.

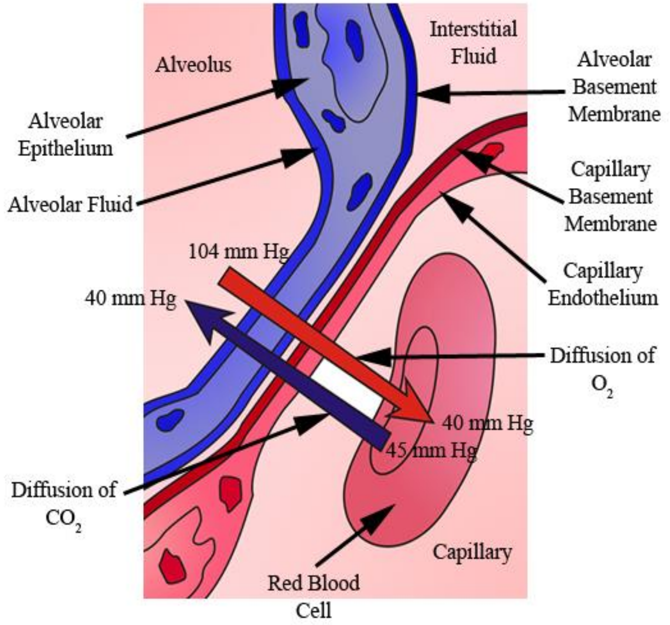


Alveolar Dead space Ventilation

- It is estimated that the alveolar dead space ventilation increases about 1 ml per year throughout adult life.
- It is unknown why this occurs but is may be associated with the structural changes involved in the aging process.

Pulmonary Gas Exchange

- The alveolar-arterial oxygen tension difference P(A - a)O2 progressively increases with age.
- This is due to several factors:
  - physiologic shunting
  - V/Q mismatch
  - decreased diffusion capacity



ABG's and Aging

- The PaO2 progressively decreases with age by about 1 mm Hg per year for each year after 60.
- The PaCO2 remains fairly constant throughout adult life due to the greater diffusion ability of CO2.
- Because the PaCO2 remains fairly constant, the pH and HCO3 also remain constant.

- It is well known that elderly patients have a pronounced increase in incidence of **pneumonia**, both bacterial and viral, compared with younger persons.
- This is due to:

1. General depression of immune system function
2. Aspiration of oropharyngeal secretions
3. The normal mechanical clearing of the tracheobronchial tree by the mucociliary apparatus is significantly slower in older persons than in younger
4. Poor oral hygiene

Pulmonary function test in the elderly :

A comparison with younger adults

Elderly patients may be at greater risk in miss diagnosis and inappropriate treatment as a consequence of pulmonary function test under utilization and tests be conducted with low quality expectation. The study sought to determine if elderly patients are able to achieve spirometry and diffusion capacity quality scores comparable to younger adult population.

Method

A prospective review of pul. function test

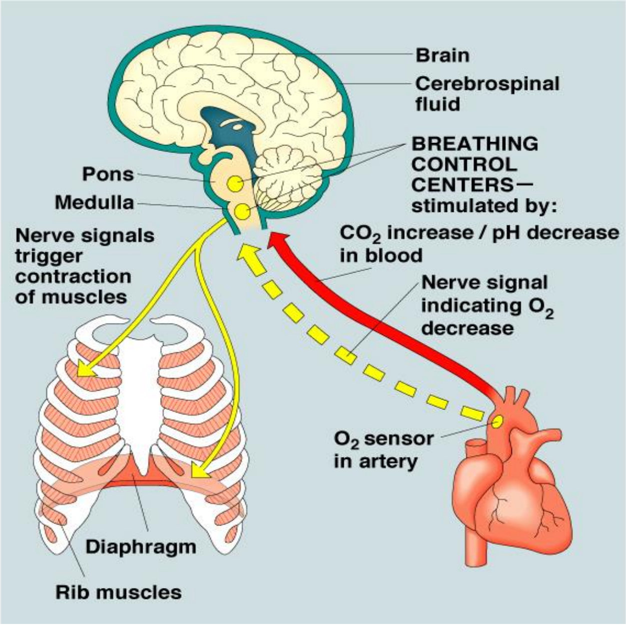
Over 22 months period . A list of every subject age more than 80 years (elderly group) and age (40 -50 years) (control group) tested during the time period was complied . The quality of spirometry and Dlco testing were examined .

Results overall, 92.6%of the elderly group and 91.5% control group spirometry test satisfy all American thoracic society (ATS)/European thoracic society acceptability and reproducibility   criteria p 0.84 .

Conclusion : elderly patients referred to hospital –based pulmonary function test lab can be expected to achieve spirometry and DLCO quality score comparable to youngeradult patiens

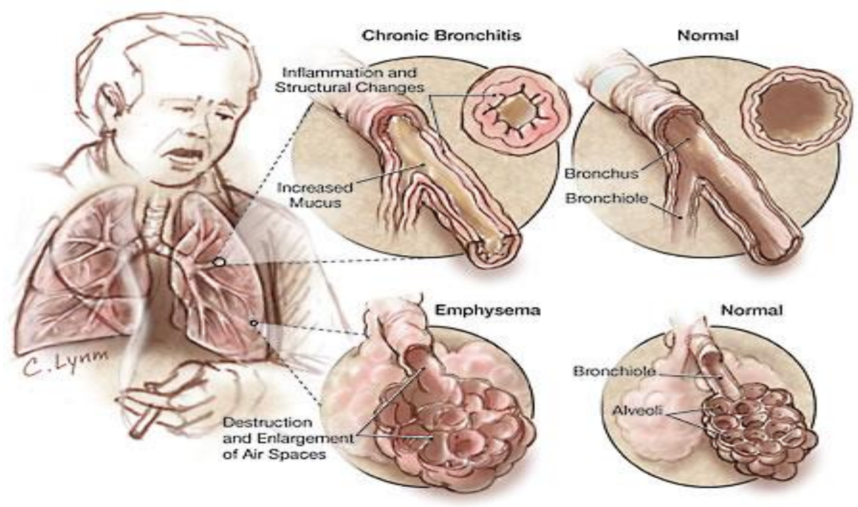
Control of Ventilation

- The ventilatory response to both hypopxia and hypercapnia diminishes with age.
- This may be due to the reduced sensitivity of the central and peripheral chemoreceptors.



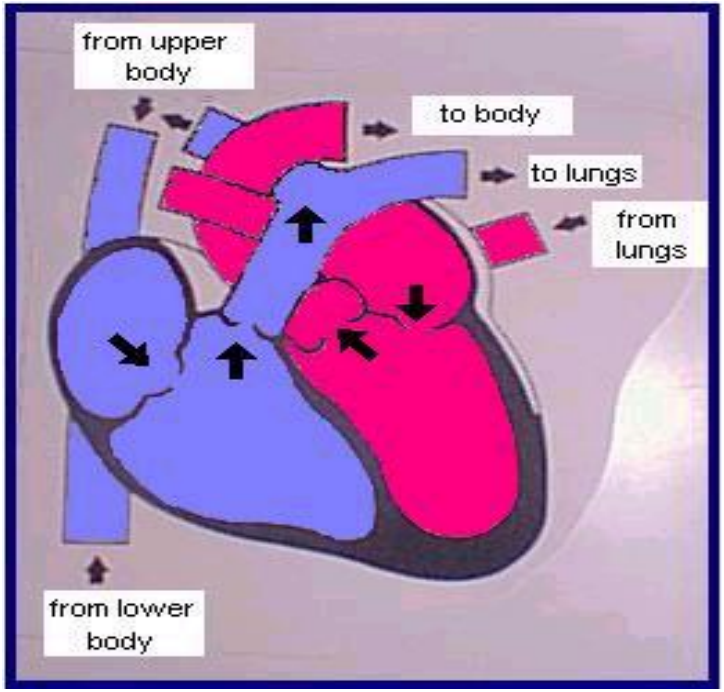
Pulmonary Disease in the Aged

- Aging is associated with the presence of chronic diseases (i.e. lung CA, bronchitis, emphysema).
- The incidence of serious infectious pulmonary diseases is significantly greater in the elderly.
- Evidence suggests that this is due to the impaired defense mechanism in the aged.



Aging and the Cardiovascular System

- A variety of adverse changes develop in the cardiovascular system with age.
- The major causes of death in the aging population are diseases of the cardiovascular system.



The major changes are in:

- Heart structure

- Heart become less elastic with age)
- Heart valves become sclerotic
- Heart muscle more irritable
- More arrhythmias
- Arteries more rigid
- Veins dilate

- cardiac output

- heart work (HR and SV) ,(By age 70 cardiac output reduced 70%)

- PVR and B/P

- The valves of the heart thicken and become stiffer.
- The number of pacemaker cells decrease and fatty & fibrous tissues increase about the SA node.

These changes may result in a slightly slower heart rate.

- The heart wall thickens, so the amount of blood that the chamber can hold may actually decrease.
- The heart may fill more slowly.
- To compensate, elderly subjects demonstrate a doubling of percent atrial contribution to filling.

- Under normal circumstances, the heart continues to adequately supply all parts of the body. However, an aging heart may be slightly less able to tolerate increased workloads.
- Examples of stressors include: illness, infections, emotional stress, injuries,

  and extreme physical exertion.

Thank you