Physiology of aging. How does the geriatric patient differs?

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What is Aging?

**Ageing** (British English) or **Aging** (American English) is the process of becoming older

- Normal aging is not a disease
- Chronologic age & physiologic age are not the same
- Individuals “age” at different rates with significant variability
Spectrum Of Aging

• **Aging**, with disease and disability

• **Usual aging**, with the absence of overt pathology, but with some declines in function

• **Successful aging** or *healthy aging*, with little or no pathology and little or no functional loss
Both in their 90’s
Our Objectives

Outline the main aging theories

Describe major age-associated changes in physiology

Understand the importance of impaired homeostasis

Be able to assess nutritional status of older adults

Be able to compare usual to successful aging
Two Main Aging Theory Categories

• **Programmed Theories**
  Aging has a biological timetable or internal biological clock

• **Error Theories**
  Aging is a result of internal or external assaults that damage cells or organs so they can no longer function properly.
Programmed vs. Error Theories

**Programmed Theories**
- Programmed Senescence Theory
- Endocrine Theory
- Immunology Theory

**Error Theories**
- Wear and Tear Theory
- Rate-of-Living Theory
- Cross-linking Theory
- Free Radical Theory
- Error Catastrophe Theory
- Somatic Mutation Theory
Telomeric Theory

- The enzyme, telomerase, fills the gap by attaching bases to the end of the chromosomes.
- With time, telomerase levels decrease.
- With decreasing telomerase levels, the telomeres become shorter and shorter.
Free Radical Theory

• During aging, damage produced by free radicals cause cells and organs to stop functioning

• The free radical theory of aging proposes that, little-by-little, small amounts of damage accumulate and contribute to deterioration of tissues and organs
Free Radicals

As the free radical (green) attacks the membrane it can release another type free radical (blue).
The free radical (blue) attacks the DNA releasing another free radical (purple).
The anti-oxidant molecule destroys the damaging free radical. The membrane repairs itself, but the DNA remains damaged, impairing the cells function. In addition, the anti-oxidant molecule now has an unpaired electron and thus becomes a new radical.
Physiology of aging: everything slows down after 30
Overview of Altered Aging Physiology

- Vision
- Endocrine system
- Skin
- Pulmonary system
- Sarcopenia
- Renal system
- Cardiovascular
- Nervous System

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Cardiovascular system

Changes in mechanics

Increase in collagen-connective tissue

Thickened & stiff heart valves

Decreased vascular compliance

Increased systolic blood pressure

Left ventricular hyperthrophy
Cardiovascular system

Changes in “control mechanisms”

Decreased responsiveness to catecholamines

Decreased maximum heart rate response

Possible congestive heart failure

\[ CO = SV \times HR \]  \{preload dependent\}

\( Co \) = cardiac output

\( SV \) = stroke volume

\( HR \) = heart rate
Pulmonary system

Reduced chest wall compliance
- increased work of breathing
- reduced maximum minute ventilation

Reduced response to hypoxia by 50%
- impaired chemoreceptor function

Reduced cough and swallowing function
- Decreased number of nerve endings in larynx

Reduced functional alveoli
- the wall become thin, the alveoli enlarge and less elastic
Pulmonary system

Pulmonary arteries thickens & enlarges resistance to blood flow in lungs

↑ Pulmonary artery pressure

Less functional alveoli (same number)
less surface area for $O_2$-$CO_2$ exchange
lower $O_2$ to supply vital organs

Especially after major trauma
Renal system

Decreased renal blood flow
600ml/min (40y) to 300ml/min (80y)

Kidney size decreases
20-30% by age 90

Decreased Glomular Filtration Rate
50% by age 75

Old kidneys have difficulty to:
- maintaining circulating blood volume
- removing excess acid
- regulate sodium homeostasis
- adjust to: hypovolemia, hemorrhage & hypotension
Renal system

Creatinine clearance vs normal serum creatinine

90 year old woman, 50 Kgr

Serum creatinine  = 1.0

Estimated creatinine clearance is?
> 90  ml/min
70-90  ml/min
50-70  ml/min
30-50  ml/min
< 30  ml/min

Creatinine Clearance = \[
\frac{[140 - \text{age (yr)}] \times \text{weight (kg)}}{72 \times \text{serum Cr (mg/dL)}}
\]
Multiply by 0.85 for women
Neurologic Changes

Brain neuronal loss throughout life
- basal ganglia atrophy
- loss is gray matter (not white matter)
↓ neuronal transmission
↓ dopamine & ↑ muscular rigidity

Impaired hearing, smell decreases

Changes in sleep cycle:
- longer to fall asleep,
- less total time of sleeping
- awakenings throughout the night
Delirium: a Geriatric syndrome

**RISK FACTORS**
- >80 years of age
- Dementia
- Functional impairments
- Sensory deficits
- Multiple comorbidities
- Meperidine

**INTERVENTIONS**
- Electrolytes/fluid
- Oxygen
- Treat infections
- Treat urinary retention
- Treat constipation
- Manage pain
- Geriatric consultation

Inouye Ann Intern Med 1993
Siddiqi Cochrane Database Sys Rev 2007
McGory Annals of Surgery 2009
Endocrine system

In most glands there is some atrophy & decreased secretion with age, but the clinical implications of this are not known.

![Diagram showing various hormonal changes associated with Menopause, Andro"pause", Somatopause, Adreno"pause", and their associated symptoms and correlations.]

- **Menopause**: Decreased Estrogen, FSH↑, LH↑, Testosterone↓, Progesterone↓?
  - Symptoms: Failing libido, depression, osteoporosis.
  - QOL issues

- **Andro"pause"**: Testosterone↓, DHT↓
  - Symptoms: Decrease in lean body mass, increased fat mass, insulin resistance, decline in immune function.

- **Somatopause**: GH↓, Sarcopenia, Lean body mass↓
  - (appetite: CCK)

- **Adreno"pause"**: DHEA↓, DHEAS↓, Cortisol↑, ACTH↑

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**Metabolic alterations**
- Insulin resistance, IGT
- Metabolic syndrome (Carcinogenesis)

**Immuno-neuro-endocrine correlations**
- Certain autoimmune processes ↑
- QOL issues

**“Synchropause”**
- Melatonin
- Sleep (?)

Not “normal” ageing process, but common: subclinical hypo- and hyperthyroidism in the elderly.
Musculoskeletal System

Sarcopenia

- ↓ muscle mass & contractile force
- reduced growth hormone production

increased fatigue & risk of falling

Sarcopenia affects all muscles

- respiratory muscles (↓ breathing)
- GI tract (constipation).
**Visual changes**

**Visual acuity**
- cataracts, macular degeneration

**Decreased lens compliance**
- Reduced accommodation
- Presbyopia

**Reduced tear formation**
- dry eyes

**Reduced pupil size**
- reduced night vision

**Loss of cones**
- reduced color vision

Predisposition to falls
Aging skin

- Delayed wound healing
- More easily damaged
- Altered thermal regulation
- Decreased sensitivity to pain-pressure
- Decreased inflammatory response
- Wrinkling, sagging skin
- Easily stretched under low loads
Malnutrition Among Older Persons

- 5-12% in community
- 30-61% hospitalized
- 40-85% in long-term care facilities.
Importance of Nutrition for Older Adults

Older Adults are at increased risk of inadequate diet from:

– Diseases - acute/chronic
– Physical limitations
– Inability to chew and poor oral health
– Social isolation/depression/low income
– Impaired functional status
– Alcohol use and abuse
– Drug - nutrient Interactions
Lifestyle modification.....

REDUCTION IN THE INCIDENCE OF TYPE 2 DIABETES WITH LIFESTYLE INTERVENTION OR METFORMIN

Diabetes Prevention Program Research Group
Stay Active.....
Benefits of Exercise

• Weight loss (↓ central adiposity)
• Blood pressure decline
• Aerobic capacity increase
• Insulin sensitivity increase

• Increase bone mass
• Increase muscle strength
• Increase perceived well being
What works better?

Regular Exercise

Reasonable body weight

“Eat your vegetables and fruit”

Don’t smoke

Remain Socially Engaged

Regular preventive health visits
  -vision, blood pressure, cholesterol, diabetes
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Summary

- Aging is associated with reduced functional reserve and a compromised ability to cope with stressors.
- Elderly are a heterogeneous group and there is great individual variability.
- Always think of interventions which may be useful in helping patients cope with and/or overcome some of the changes brought by normal aging.
- Start building your reserves NOW.