Clinical Impact of Physiologic Changes of Aging

Geriatrics Curriculum Project
Annie Wang, Medical Student
Richard W. Besdine, MD

ALPERT MEDICAL SCHOOL | BROWN | DONALD W. REYNOLDS FOUNDATION

NERVOUS SYSTEM		
Pure Aging Change	**Change in Physical Exam**	**Clinical Consequence**
↓ dopamine neurons	↓ arm swing, ↓ tone	↑ risk for Parkinson disease
↓ baroreflex sensitivity	Orthostatic hypotension	Postural dizziness; falls and syncope risk
	↓ ability to prevent postural sway	
Underlying change not identified	↓ decreased hand and foot tapping speed	None
	Reemergence of primitive reflexes	Mistaken as sign of dementia
	Restricted upward gaze	None
Decline in complex central processing	↓ DTRs	None
	↓ vibratory sense in feet	Fall risk
	↓ gag reflex	↑risk of choking, aspiration

MEMORY		
Pure Aging Change	**Change in Physical Exam**	**Clinical Consequence**
↓ episodic memory	↓memory for events, time, place	May be mistaken for dementia
↑ reaction time ↓ free recall		↓ completion of timed tasks ↓ information retrieval ↓ retrieval of names of persons, objects
more easily distracted		↓ multi-tasking abilities
Most memory functions don't change with pure aging – no change in immediate memory, recognition, short term memory, longer term memory for tasks, vocabulary		

CARDIOVASCULAR SYSTEM			
Elements	**Pure Aging Change**	**Change in Physical Exam**	**Clinical Consequence**
Myocytes	↓ number, ↑ size; ↑ fibrocytes	Cardiomegaly	↑ risk for diastolic congestive heart failure (DCHF) – cardiac output more dependent on high filling pressure; less tolerant of volume depletion w/ diuretics
LV stiffness	↑ (↓ compliance)		
LV wall thickness	↑		
Systemic vascular resistance	↑		
Left atrium	↑		
LV passive diastolic filling	↓ (makes atrial contraction more important)		• In presence of AF, inadequate cardiac output easily provoked • Atrial arrhythmias common
Sinus node atrophy	dysfunction		
CV reserve	↓		↑ CHF risk
BP and Pulse Pressure	↑		↑ risk for HTN, stroke
Autonomic function	dysregulation		↑ risk for ventricular ectopy
Valves	sclerosis and calcification		↑ risk for murmurs, sometimes stenosis
Fibrinogen, factors V, VIII, IX	↑		↑ risk for thrombosis ↑ risk for embolic stroke
Baroreflex sensitivity	↓		↑ risk for syncope

CARDIOVASCULAR SYSTEM (2)		
Pure Aging Change	**Change in Physical Exam**	**Clinical Consequence**
Arterial system		
↑ vascular stiffness ↑ pulsatile load ↑ overall wall thickness ↓ endothelial peptide function ↓ NO production	Palpable vessels Bounding pulses Net ↑ SBP, PP	↑BP, Stroke & Cardiovascular risks

PULMONARY SYSTEM		
Pure Aging Change	**Change in Physical Exam**	**Clinical Consequence**
↓ elasticity (↑ stiffness), ↓ alveolar exchange area	None	↓ maximum respiratory rate
↓ arterial PaO2 throughout midlife → constant > 65 yrs (~80 mmHg)	"	More easily provoked desaturation, but baseline varies
↑ V/Q mismatch	"	None
↑ FEV1 (30 ml/yr >30 yrs)	Prolonged expiration	CO2 retention

RENAL SYSTEM			
Pure Aging Change		**Change in Physical Exam**	**Clinical Consequence**
Renal weight	↓ 20-30% by age 80		
Glomeruli	# ↓ 30-50% by 80		
	Hypertrophy, hyperfiltration		
Sclerotic Glomeruli	↑ %	Glomerular filtration rate ↓ 1 ml/min/yr>40 Creatinine clearance ↓ in step with GFR; imperative to calculate C_{CR} in elders	
	↓ overall function		
	↓renal blood flow 10%/ decade		
	Delayed response to salt or water load		
	↓renal tubular secretion		
Calculating C_{CR}			
Estimate by Cockcroft and Gault equation		Estimate by MDRD (modification of diet in RD)	
$\frac{\text{(Ideal weight in kg) (140-age)}}{\text{(72) (serum creatinine in mg/dL)}}$ (0.85 if female)		http://www.kidney.org/professionals/kdoqi/gfr_calculator.cfm	

GASTROINTESTINAL SYSTEM			
Pure Aging Change		**Change in Physical Exam**	**Clinical Consequence**
Small bowel	Minor alteration in motility (dysrhythmia)	None	May contribute to complaints of constipation
Esophagus	Abnormal peristalsis	"	Reflux symptoms
	Longer duration of reflux	"	
Gastric function	↓ motility, blood flow	"	• Drug toxicity • GI bleeds • ASA less absorbed, L-Dopa more absorbed
	↑ emptying time, ↑ contact with Rx (NSAIDS)		
	↓ acid production		
Larynx	Delayed elevation	"	Aspiration risk
Pharynx	↓ clearance	"	Aspiration risk
Colon	None	"	Constipation common

GYNECOLOGY

Elements	Pure Aging Change	Change in Physical Exam	Clinical Consequence
Breast	Atrophy, fibrous thickening	Lump detection more difficult	Late detection of cancer
External genitalia			
Labia		Thinning, wrinkling, pallor, easily traumatized	
Clitoris		Enlargement	
Internal genitalia			
Vagina	Atrophy, friability, shortening, shrinkage, decreased secretions (pH up), ↓ rugae, ↓squamous maturation, mucosa thins	Easily traumatized	Painful intercourse
Cervix	Atrophy		
Ovaries	Atrophy	Should not be palpable 10+ years after menopause	Estrogen deprivation
Urethra	Functional length Closing pressure ↓ Mucosa atrophies		Risk for urinary incontinence, UTI
Uterus	Small	Should not be palpable 10+ years after menopause	Late detection of cancer

MALE GENITOURINARY SYSTEM

Elements	Pure Aging Change	Change in Physical Exam	Clinical Consequence
Breast	Enlargement	Tenderness	Late detection of cancer
External genitalia			
Scrotum		Thinning, pallor	
Internal genitalia			
Prostate	Benign hyperplasia	Enlargement	Urinary symptoms
Urethra	Closing pressure ↓		Risk for incontinence
Other			
Testosterone	Deficiency	End organ atrophy – testes, bone, muscle	? Frailty
Semen	↓ volume ↓ motility ↑ abnormal spermatozoa		? Fetal abnormalities
Erection	↓ duration, firmness, frequency ↑ refractory period		Erectile dysfunction Sexual difficulties

BODY COMPOSITION AND METABOLISM

Pure Aging Change		Change in Physical Exam	Clinical Consequence
Weight	↑ to mid-60s in ♂, 70s in ♀; then ↓ in older age		BMI underestimates obesity in elders
Body Mass Index↓		↑ Fat Mass ↓ Fat Free Mass	Comorbility and disability in obese elders
			Co-existing sarcopenia → major ↓ function
			Weight loss and muscle building are beneficial
Glucose Metabolism	Glucose intolerance (insulin resistance [IR]) obligatory with aging		Greatly exacerbated by inactivity, diet, medications
	No Δ in insulin & its receptors ↓ Glucose transporters in cell		↑ risk stroke, CV events

SUPPORTING SYSTEMS

Pure Aging Change		Change in Physical Exam	Clinical Consequence
Bone			
Resorption	↑	None	Osteoporosis risk Fractures Nursing home institutionalization Reduced quality of life
New bone formation	No change		
Bone Mineral Density	↓		
Osteoblasts	↓	"	
Osteoclasts	↑	"	
Skin			
Dermal thickness and vascularity	Decrease	None	Wrinkles Cancer risk Lower bone building ability
Provitamin D3 production by keratinocytes			
Melanocytes in skin			
Eccrine glands			
Proliferative potential of keratinocytes			

IMMUNE SENESCENCE

Pure Aging Change		Change in Physical Exam	Clinical Consequence
Overall function	↓	None	↑ risk for cancer, severe infection
B cells	↓ antibody production ↑ auto-antibodies # unchanged	"	Vaccinate elders in 60s (PN, Flu) ↓ auto-immune diseases
Thymus	Involution	"	↓delayed hypersensitivity need for 2-step TB skin testing
T cells	↓ helper ↑ killer # unchanged ↓ proliferative response	"	Uncertain
Cytokines	↓ IL-2	"	"
Increase in inflammatory markers		If severe, physical function decline	If severe →frailty, multiple chronic diseases

SPECIAL SENSES

Pure Aging Change		Change in Physical Exam	Clinical Consequence
Vision	↓accommodation (presbyopia)	↑focal length	Reading glasses
	↓attentional visual field	Visual neglect	Potential injury
Hearing	↓ acuity (presbycusis), especially high tones (consonants) – 50% clinically important	Abnormal gross hearing test and Rinne, Weber exam	↓speech discrimination
Taste	↓ salt detection ↓ vol, quality of saliva Bitter exaggerated Sweet and sour perception – no Δ		↓ interest in food
Smell	↓ central processing ↓ perception olfactory bulb atrophy	↓ability to detect, differentiate odors	↓ interest in food, danger from noxious and malodorous substances