

**Appendix 2: Geriatric Assessment and Pharmacotherapy**

**INTRODUCTION**

TABLE A2-1

**Physiologic Changes with Aging**

Organ System	Manifestation
Balance and gait	<ul style="list-style-type: none"> <li>↓ Stride length and slower gait</li> <li>↓ Arm swing</li> <li>↑ Body sway when standing</li> </ul>
Body composition	<ul style="list-style-type: none"> <li>↓ Total body water</li> <li>↓ Lean body mass</li> <li>↑ Body fat</li> <li>↔ or ↓ Serum albumin</li> <li>↑ α<sub>1</sub>-Acid glycoprotein (↔ or ↑ by several disease states)</li> </ul>
Cardiovascular	<ul style="list-style-type: none"> <li>↓ Cardiovascular response to stress</li> <li>↓ Baroreceptor activity leading to ↑ orthostatic hypotension</li> <li>↓ Cardiac output</li> <li>↑ Systemic vascular resistance with loss of arterial elasticity and dysfunction of systems maintaining vascular tone</li> <li>↑ Afterload</li> <li>↓ Coronary perfusion</li> </ul>
Central nervous system	<ul style="list-style-type: none"> <li>↓ Size of the hippocampus and frontal and temporal lobes</li> <li>↓ Number of receptors of all types and ↑ sensitivity of remaining receptors</li> <li>↓ Short-term memory, coding and retrieval, and executive function</li> <li>Altered sleep patterns</li> </ul>
Endocrine	<ul style="list-style-type: none"> <li>↓ Estrogen, testosterone, thyroid-stimulating hormone, and DHEA-S levels</li> <li>Altered insulin signaling</li> </ul>
Gastrointestinal	<ul style="list-style-type: none"> <li>↓ Motility of the large intestine</li> <li>↓ Vitamin absorption by active transport mechanisms</li> <li>↓ Splanchnic blood flow</li> <li>↓ Bowel surface area</li> </ul>
Genitourinary	<ul style="list-style-type: none"> <li>Atrophy of the vagina with decreased estrogen</li> <li>Prostatic hypertrophy with androgenic hormonal changes</li> <li>Detrusor hyperactivity may predispose to incontinence</li> </ul>
Hepatic	<ul style="list-style-type: none"> <li>↓ Hepatic size</li> </ul>

	<ul style="list-style-type: none"> <li>↓ Hepatic blood flow</li> <li>↓ Phase I (oxidation, reduction, hydrolysis) metabolism</li> </ul>
Immune	<ul style="list-style-type: none"> <li>↓ Antibody production in response to antigen</li> <li>↑ Autoimmunity</li> </ul>
Oral	<ul style="list-style-type: none"> <li>Altered dentition</li> <li>↓ Ability to taste salt, bitter, sweet, and sour</li> </ul>
Pulmonary	<ul style="list-style-type: none"> <li>↓ Respiratory muscle strength</li> <li>↓ Chest wall compliance</li> <li>↓ Arterial oxygenation and impaired carbon dioxide elimination</li> <li>↓ Vital capacity</li> <li>↓ Maximal breathing capacity</li> <li>↑ Residual volume</li> </ul>
Renal	<ul style="list-style-type: none"> <li>↓ Glomerular filtration rate</li> <li>↓ Renal blood flow</li> <li>↓ Filtration fraction</li> <li>↓ Tubular secretory function</li> <li>↓ Renal mass</li> </ul>
Sensory	<ul style="list-style-type: none"> <li>Presbyopia (diminished ability to focus on near objects)</li> <li>↓ Night vision</li> <li>Presbycusis (high-pitch, high-frequency hearing loss)</li> <li>↓ Sensation of smell and taste</li> </ul>
Skeletal	<ul style="list-style-type: none"> <li>↓ Skeletal bone mass (osteopenia)</li> <li>Joint stiffening due to reduced water content in tendons, ligaments, and cartilage</li> </ul>
Skin/Hair	<ul style="list-style-type: none"> <li>Thinning of stratum corneum</li> <li>↓ Langerhans cells, melanocytes, and mast cells</li> <li>↓ Depth and extent of the subcutaneous fat layer</li> <li>Thinning and graying of hair due to more hairs in the resting phase and shortening of the growth phase as well as changes in follicular melanocytes</li> </ul>

Source: Data from Cefalu CA. Theories and mechanisms of aging. *Clin Geriatr Med.* 2011;27:491–506; Alvis BD, Hughes CG. Physiology considerations in geriatric patients. *Anesthesiol Clin.* 2015;33:447–456.

TABLE A2-2

Age-Related Changes in Drug Pharmacokinetics

Pharmacokinetic Phase	Pharmacokinetic Parameters
Gastrointestinal absorption	Unchanged passive diffusion and no change in bioavailability for most drugs ↓ Active transport and ↓ bioavailability for some drugs ↓ First-pass metabolism, ↑ bioavailability for some drugs, and ↓ bioavailability for some prodrugs
Distribution	↓ Volume of distribution and ↑ plasma concentration of water-soluble drugs ↑ Volume of distribution and ↑ terminal disposition half-life ( $t_{1/2}$ ) for lipid-soluble drugs
Hepatic metabolism	↓ Clearance and ↑ $t_{1/2}$ for some drugs with poor hepatic extraction (capacity-limited metabolism). Phase I metabolism may be affected more than Phase II ↓ Clearance and ↑ $t_{1/2}$ for drugs with high hepatic extraction ratios (flow-limited metabolism)
Renal excretion	↓ Clearance and ↑ $t_{1/2}$ for renally eliminated drugs and active metabolites

Source: Data from Reeve E, Wiese MD, Mangoni AA. Alterations in drug disposition in older adults. *Expert Opin Drug Metab Toxicol.* 2015;11:491–508; Shi S, Klotz U. Age-related changes in pharmacokinetics. *Curr Drug Metab.* 2011;12:601–610.

TABLE A2-3

**Comparison of American Geriatrics Society Beers Criteria and STOPP Criteria**

Criteria	Organization
Beers	<p>Criteria are organized into five tables:</p> <ol style="list-style-type: none"> <li>1. PIMs for all older adults, organized according to organ system and therapeutic category</li> <li>2. PIMs for some older adults due to drug–disease or drug–syndrome interactions that might exacerbate disease/syndromes (eg, syncope, delirium, dementia, history of falls or fractures, history of gastrointestinal ulcers, urinary incontinence, benign prostatic hyperplasia, heart failure)</li> <li>3. PIMs to be used with caution (eg, aspirin for primary prevention, dabigatran/rivaroxaban—gastrointestinal bleeding in people &gt;75 years)</li> <li>4. Potentially clinically important drug–drug interactions that should be avoided (eg, opioids, lithium, phenytoin, warfarin, avoid total of ≥3 CNS active drugs to reduce falls risk)</li> <li>5. Medications that should be avoided or have dosage reduced with varying levels of kidney function</li> </ol>
STOPP	<ol style="list-style-type: none"> <li>1. Organized according to physiological system (11 sections) and include drugs to avoid, drug–drug, dosing considerations for reduced renal function, and drug–disease interactions</li> <li>2. A section focused on general concepts that are not medication specific and include drug prescribed without evidence-based clinical indication, drug prescribed without recommended duration, and therapeutic duplication</li> </ol>

Source: Data from O’Mahony D, O’Sullivan D, Byrne S, O’Connor MN, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: Version 2. *Age Ageing*. 2015;44:213–218; 2019 American Geriatrics Society Beers Criteria Update Expert Panel. *American Geriatrics Society 2019 updated Beers Criteria for potentially inappropriate medication use in older adults*. *J Am Geriatr Soc*. 2019. doi:10.1111/jgs.15767.

PIM, potentially inappropriate medication.

TABLE A2-4

**Medication Appropriateness Index**

<p>Questions to ask about each individual medication</p> <ol style="list-style-type: none"> <li>1. Is there an indication for the medication?</li> <li>2. Is the medication effective for the condition?</li> <li>3. Is the dosage correct?</li> <li>4. Are the directions correct?</li> <li>5. Are the directions practical?</li> <li>6. Are there clinically significant drug–drug interactions?</li> <li>7. Are there clinically significant drug–disease interactions?</li> <li>8. Is there unnecessary duplication with other medication(s)?</li> <li>9. Is the duration of therapy acceptable?</li> <li>10. Is this medication the least expensive alternative compared with others of equal utility?</li> </ol>
--

Source: Reprinted from Hanlon JT, Schmader KE, Samsa GP, et al. A method for assessing drug therapy appropriateness. *J Clin Epidemiol*. 1992;45:1045–1051.

TABLE A2-5

**Examples of Clinically Important Drug–Disease Interactions Determined by Expert Panel Consensus**

Disease	Drug or Drug Class
Heart failure	NSAIDs, COX-2 inhibitors, thiazolidinediones, <a href="#">dronedarone</a>
Heart failure with reduced ejection fraction	Nondihydropyridine calcium channel blockers
Syncope	Acetylcholinesterase inhibitors, peripheral nonselective $\alpha_1$ -blockers, tertiary tricyclic antidepressants, antipsychotics
Delirium	Anticholinergics, antipsychotics, benzodiazepines, corticosteroids, H <sub>2</sub> -receptor antagonists, <a href="#">zolpidem</a> and <a href="#">zoleplon</a> (“z-hypnotics”)
Cognitive impairment	Anticholinergics, antipsychotics, benzodiazepines, nonbenzodiazepine hypnotics, z-hypnotics
History of falls	Antiepileptics, antipsychotics, benzodiazepines, antidepressants, z-hypnotics, opioids
Parkinson disease	Antipsychotics (except <a href="#">quetiapine</a> , <a href="#">clozapine</a> , <a href="#">pimavanserin</a> ), <a href="#">metoclopramide</a> , <a href="#">prochlorperazine</a> , <a href="#">promethazine</a>
Peptic ulcer disease	<a href="#">Aspirin</a> in doses of 325 mg/day or more, NSAIDs
Chronic kidney disease stage IV and higher	NSAIDs
Urinary incontinence in women	Peripheral $\alpha_1$ -blockers

COX-2, cyclooxygenase 2; NSAIDs, nonsteroidal anti-inflammatory drugs.

Source: Data from 2019 American Geriatrics Society Beers Criteria Update Expert Panel. American Geriatrics Society 2019 updated Beers Criteria for potentially inappropriate medication use in older adults. *J Am Geriatr Soc.* 2019. doi:10.1111/jgs.15767.

TABLE A2-6

**Atypical Disease Presentation in Older Adults**

Disease	Presentation
Acute myocardial infarction	Only ~50% present with chest pain. In general, older adults present with weakness, confusion, syncope, and abdominal pain; however, electrocardiographic findings are similar to those in younger patients.
Congestive heart failure	Instead of dyspnea, older patients may present with hypoxic symptoms, lethargy, restlessness, and confusion.
Gastrointestinal bleed	Although the mortality rate is ~10%, presenting symptoms are nonspecific, ranging from altered mental status to syncope with hemodynamic collapse. Abdominal pain often is absent.
Upper respiratory infection	Older patients typically present with lethargy, confusion, anorexia, and decompensation of a preexisting medical condition. Fever, chills, and productive cough may or may not be present.
Urinary tract infection	Dysuria, fever, and flank pain may be absent. More commonly, older adults present with incontinence, confusion, abdominal pain, nausea or vomiting, and azotemia.

(See the following chapters for more detailed discussions of these topics:

- e/Chapter 22, *Geriatrics: The Aging Process in Humans and Its Effects on Physiology*, authored by Krista L. Donohoe, Elvin T. Price, Tracey L. Gendron, and Patricia W. Slattum
- e/Chapter 23: *Prescribing in the Older Adult*, authored by Emily R. Hajjar, Lauren R. Hersh, and Shelly L. Gray
- e/Chapter 24: *Assessing Health and Delivering HealthCare to Older Adults*, authored by Leigh Ann Mike, Zachary A. Marcum, and Shelly L. Gray)