ICP/API Guidelines on Rational Prescribing Practices in the Elderly

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CHAPTER

Age-related Physiological and Pharmacokinetic–Pharmacodynamic Changes

ABSTRACT

Aging is associated with progressive physiological changes across various body systems, influencing pharmacokinetics and pharmacodynamics. These changes alter drug absorption, distribution, metabolism, and excretion while modifying receptor sensitivity and homeostatic regulation. In the elderly, these factors elevate the risk of adverse drug events (ADEs) and therapeutic inefficacy. This chapter provides an in-depth analysis of age-related changes in key physiological systems, emphasizing their clinical implications and practical management strategies. Highlighted are the impacts on the nervous, cardiovascular, respiratory, gastrointestinal, musculoskeletal, endocrine, and renal systems, with tailored recommendations for rational prescribing. Through illustrative case scenarios, the chapter offers actionable insights for optimizing therapeutic outcomes while minimizing ADEs in the elderly.

INTRODUCTION

The process of aging entails a series of complex physiological changes that affect multiple systems in the human body. These changes impact functional capacity, resilience to environmental stressors, and susceptibility to diseases. In clinical practice, these physiological shifts significantly influence how elderly patients respond to medications. The altered pharmacodynamic (PD) and pharmacokinetic (PK) profiles necessitate tailored prescribing strategies to ensure efficacy and safety.

This chapter examines age-related changes in key body systems and their pharmacological implications. By understanding these changes, clinicians can adopt evidence-based prescribing practices, minimize the risks of ADEs, and address the unique needs of the elderly. The chapter integrates detailed insights into physiological alterations, pharmacological adjustments, and practical scenarios to bridge the gap between theory and clinical practice.

Aging is characterized by progressive and cumulative physiological changes across various systems in the body. These changes impact an individual's functional capacity, ability to adapt to environmental stressors, and susceptibility

to diseases. The following is a detailed analysis of the age-related changes in key physiological systems.

NERVOUS SYSTEM

Aging significantly affects the nervous system leading to structural and functional changes that impair cognition, motor skills, and sensory perception. **Table 1** outlines the key age-related physiological changes in the nervous system, highlighting their specific impacts on memory, mood, coordination, and overall neurological health.

Key Changes

- *Neuron loss:* Gradual loss of neurons in the brain and spinal cord affects signal transmission.
- *Reduced neurotransmitter levels:* Decline in dopamine, serotonin, and acetylcholine contributes to slower reaction times, mood changes, and memory impairment.
- *Cerebral atrophy:* Reduction in brain volume, especially in the hippocampus and cortex, impairs memory and executive function
- *Slower reflexes:* Decreased speed of signal transmission affects motor responses and balance.

Clinical Implications

- Increased risk of neurodegenerative diseases (e.g., Alzheimer's, Parkinson's)
- Slower cognitive processing and impaired coordination
- Higher susceptibility to falls and injuries due to diminished reflexes

CARDIOVASCULAR SYSTEM

The cardiovascular system undergoes structural and functional deterioration with age, increasing the risk of cardiovascular diseases. **Table 2** summarizes the physiological changes in the cardiovascular system due to aging, emphasizing their effects on heart function, blood pressure (BP) regulation, and vascular health.

Key Changes

- *Reduced cardiac output:* A decline in heart muscle elasticity and contractility reduces pumping efficiency.

TABLE 1: Age-related changes in nervous system function and their clinical impact.

Parameter	Age-related change	Impact
Neurotransmitters	Reduced dopamine and serotonin levels	Memory loss, mood changes, and slower reflexes
Hippocampus volume	Shrinkage	Impaired learning and memory retention
Motor neuron efficiency	Decline	Poor coordination and increased fall risk

TABLE 2: Cardiovascular system changes with aging and their clinical implications.

Parameter	Age-related change	Impact
Heart elasticity	Decrease	Reduced pumping efficiency
Arterial compliance	Stiffening	Hypertension and increased cardiovascular workload
Baroreceptor sensitivity	Decrease	Orthostatic hypotension and dizziness

TABLE 3: Respiratory system alterations in aging and their effects.

Parameter	Age-related change	Impact
Lung compliance	Reduced elasticity	Decreased vital capacity and exercise tolerance
Alveolar surface area	Decreased	Impaired gas exchange and lower oxygen levels
Respiratory muscles	Weakness	Difficulty in deep breathing

- *Vascular stiffness:* Thickening and stiffening of arterial walls increase BP.
- *Reduced baroreceptor sensitivity:* Impaired regulation of BP leads to orthostatic hypotension.
- *Increased peripheral resistance:* Reduced arterial compliance contributes to systemic hypertension.

Clinical Implications

- Higher risk of hypertension, atherosclerosis, and heart failure
- Reduced exercise tolerance and slower recovery from physical exertion
- Increased risk of postural dizziness and falls

RESPIRATORY SYSTEM

Aging impacts the respiratory system's structure and function, reducing lung capacity and gas exchange efficiency. **Table 3** highlights the key respiratory system changes associated with aging, detailing their impacts on lung function, gas exchange efficiency, and breathing capacity.

Key Changes

- *Decreased lung elasticity:* Loss of elastin fibers leads to reduced lung compliance.
- *Weakened respiratory muscles:* Diaphragm and intercostal muscles lose strength, limiting airflow.
- *Decline in alveolar surface area* reduces gas exchange capacity.
- *Impaired ciliary function* hinders mucus clearance, increasing infection risk.

Clinical Implications

- Reduced ability to tolerate physical activity
- Increased risk of respiratory infections, such as pneumonia
- Decreased oxygenation during exertion

GASTROINTESTINAL SYSTEM

Aging affects the gastrointestinal (GI) system's motility, secretion, and absorption functions. **Table 4** describes the physiological changes in the GI system with aging, focusing on their effects on digestion, nutrient absorption, and GI health.

Key Changes

- *Slowed peristalsis:* Reduced muscle tone leads to slower bowel movements.
- *Reduced gastric acid secretion:* Decreases nutrient absorption, particularly calcium, iron, and vitamin B12
- *Atrophic gastric mucosa:* Increased risk of GI discomfort and infections
- *Weakened sphincters:* Increased risk of gastroesophageal reflux disease (GERD)

Clinical Implications

- Increased risk of constipation and nutrient deficiencies
- Higher susceptibility to acid reflux and gastritis
- Reduced tolerance to certain medications due to altered metabolism

MUSCULOSKELETAL SYSTEM

The musculoskeletal system undergoes structural degeneration, reducing strength, mobility, and independence. **Table 5** outlines the primary age-related changes in the musculoskeletal system, emphasizing their effects on bone health, muscle strength, and joint functionality.

Key Changes

- *Loss of bone density:* Accelerates after menopause in women, increasing fracture risk
- *Sarcopenia:* Progressive muscle mass loss leads to weakness and frailty
- *Joint degeneration:* Cartilage erosion and stiffening reduce joint mobility

TABLE 4: Age-related changes in gastrointestinal function and their clinical impact

Parameter	Age-related change	Impact
Peristalsis	Slower	Constipation and increased transit time
Gastric acid production	Decrease	Impaired nutrient absorption
Sphincter strength	Weakening	Increased risk of GERD

(GERD: gastroesophageal reflux disease)

TABLE 5: Musculoskeletal system changes with aging and their implications.

Parameter	Age-related change	Impact
Bone density	Reduction	Increased fracture risk
Muscle mass	Decline due to sarcopenia	Weakness and reduced mobility
Joint cartilage	Degeneration	Stiffness and joint pain

Clinical Implications

- Higher risk of falls, fractures, and osteoarthritis
- Reduced physical activity and independence
- Increased disability and dependency on daily activities

ENDOCRINE SYSTEM

Aging alters hormonal regulation, affecting metabolism, growth, and homeostasis. **Table 6** highlights the significant endocrine changes associated with aging, focusing on their impact on metabolism, muscle and fat composition, and bone health.

Key Changes

- *Reduced growth hormone:* Leads to loss of lean body mass and increased fat mass
- *Decline in sex hormones:* Reduced estrogen and testosterone levels impact bone density and muscle mass.
- *Impaired glucose regulation:* Decreased insulin sensitivity raises the risk of type 2 diabetes.
- *Thyroid function changes:* Subtle alterations in thyroid hormone levels may affect metabolic rate.

Clinical Implications

- Increased prevalence of osteoporosis and sarcopenia
- Higher risk of metabolic syndrome and diabetes
- Suboptimal adaptation to stress and energy demands

RENAL AND URINARY SYSTEM

Aging affects renal function, compromising the body's ability to regulate fluid and electrolyte balance. **Table 7** summarizes the physiological changes in the renal

TABLE 6: Endocrine system changes in aging and their clinical effects.

Parameter	Age-related change	Impact
Growth hormone	Decline	Loss of muscle and increased fat mass
Insulin sensitivity	Reduced	Increased risk of type 2 diabetes
Sex hormones	Decreased	Bone loss and reduced muscle mass

TABLE 7: Renal and urinary system alterations with aging and their effects.

Parameter	Age-related change	Impact
GFR	Decline	Reduced drug clearance and waste excretion
Bladder elasticity	Loss of tone	Increased urinary urgency and incontinence
Renal blood flow	Decrease	Impaired kidney function

(GFR: glomerular filtration rate)

and urinary systems due to aging, detailing their impact on kidney function, waste excretion, and urinary control.

Key Changes

- *Reduced glomerular filtration rate (GFR):* Declines by up to 50% by age 80
- *Loss of nephrons:* Reduces kidney filtering capacity
- *Decreased renal blood flow:* Limits nutrient and oxygen supply to the kidneys
- *Bladder elasticity decline:* Leads to urinary urgency and incontinence

Clinical Implications

- Altered drug clearance, necessitating dose adjustments
- Increased risk of dehydration and electrolyte imbalance
- Higher prevalence of urinary incontinence and infections

Age-related physiological changes affect all major systems in the body, leading to increased vulnerability to diseases and functional impairments. A thorough understanding of these changes is crucial for developing targeted strategies to mitigate their effects and improve the quality of life for the elderly population. Effective interventions include lifestyle modifications, pharmacological adjustments, and regular monitoring of health parameters.

CLINICAL CASE SCENARIOS: PRACTICAL IMPLICATIONS OF AGE-RELATED PHYSIOLOGICAL CHANGES

Case 1: Impaired Drug Clearance and Renal Function

Background

Mrs S, a 78-year-old woman with a history of hypertension and type 2 diabetes, presents with confusion, reduced urine output, and mild swelling in her legs. She was recently prescribed a nonsteroidal anti-inflammatory drug (NSAID) for knee pain.

Discussion

Mrs S's symptoms highlight age-related changes in renal function:

- *Key changes in renal system*:
  - Declined GFR has reduced her ability to clear renally excreted drugs.
  - NSAIDs impair renal perfusion by inhibiting prostaglandins, exacerbating her renal insufficiency.
  - Loss of nephron functionality and decreased renal blood flow increase her susceptibility to acute kidney injury.

Management

- Discontinue NSAIDs and start a kidney-friendly analgesic such as acetaminophen.
- Monitor renal function through creatinine clearance and GFR.
- Adjust antihypertensive medications as necessary to avoid further renal damage.

Clinical Pearls

- Renal insufficiency in the elderly necessitates careful selection and dose adjustment of renally excreted drugs.
- Regular monitoring of renal parameters is crucial to prevent drug-induced nephrotoxicity.

Case 2: Cardiovascular Complications and Baroreceptor Sensitivity

Background

Mr R, an 82-year-old man, presents to the emergency department after experiencing dizziness and a fall. He reports feeling lightheaded when standing and has a history of hypertension managed with a beta-blocker and diuretic.

Discussion

Mr R's presentation underscores cardiovascular system changes due to aging:

- *Key changes in cardiovascular system*:
  - Reduced *baroreceptor sensitivity* contributes to orthostatic hypotension, causing dizziness on standing.
  - Decreased arterial compliance and vascular stiffness exacerbate BP-regulation difficulties.
  - Diuretic use may have led to dehydration, further aggravating his symptoms.

Management

- Gradual tapering of the diuretic dosage while maintaining fluid balance.
- Educate the patient on postural changes to minimize dizziness (e.g., rising slowly from a seated or lying position).
- Consider a different class of antihypertensive medication with less impact on blood pressure regulation.

Clinical Pearls

- Orthostatic hypotension is a common issue in the elderly due to reduced baroreceptor responsiveness.
- Medication regimens for hypertension must account for age-related cardiovascular changes and risks of falls.

Case 3: Nutritional Deficiencies and Gastrointestinal Function

Background

Ms K, a 74-year-old woman, complains of chronic fatigue, constipation, and frequent heartburn. She has a poor appetite and reports difficulty in swallowing certain foods. She takes a proton pump inhibitor (PPI) for GERD.

Discussion

Ms K's symptoms reflect GI changes associated with aging.

- *Key changes in GI system*:
  - Reduced *gastric acid secretion* impairs absorption of essential nutrients like calcium, iron, and vitamin B12.

- Weakened sphincter strength predisposes her to GERD symptoms.
- Slowed peristalsis contributes to her constipation.

Management

- Assess for nutrient deficiencies through serum tests (e.g., vitamin B12 and ferritin levels).
- Address constipation with increased dietary fiber, adequate hydration, and possible use of stool softeners.
- Consider reducing PPI dosage or switching to an H2-receptor antagonist to minimize nutrient malabsorption risks.

Clinical Pearls

- Chronic PPI use in the elderly can exacerbate nutrient deficiencies due to reduced gastric acid production.
- Management of constipation requires a multipronged approach, including dietary changes and physical activities.

These clinical scenarios emphasize the importance of understanding and addressing age-related physiological changes across systems. Effective management strategies include individualized treatment plans, close monitoring of medications, and lifestyle modifications tailored to the elderly patient's needs. By integrating these principles, healthcare providers can optimize care and improve outcomes for older adults.

CHANGES IN PHARMACOKINETICS IN THE ELDERLY

Pharmacokinetics refers to the processes of drug absorption, distribution, metabolism, and excretion. Age-related physiological changes alter these processes, which can impact the efficacy and safety of medications. This section explores these changes in detail with expanded examples and clinical implications.

Absorption

Absorption involves the movement of drugs from the site of administration into the bloodstream. In the elderly, the overall absorption rate of most drugs remains unchanged. However, specific physiological and pathological changes in the GI tract may influence certain drugs.

Key Changes in Absorption

- *Increased gastric pH*:
  - Age-related reduction in gastric acid secretion leads to a higher gastric pH (hypochlorhydria).
  - Drugs like calcium carbonate, iron salts, and ketoconazole, which require an acidic environment for absorption, show reduced bioavailability.
  - Conversely, drugs like aspirin that are stable in acidic environments may undergo altered absorption.
- *Slower gastric emptying and GI motility*:
  - Drugs such as paracetamol (acetaminophen) may have delayed onset of action due to slower gastric emptying.
  - This delay is exacerbated by conditions like diabetes gastroparesis, which are more common in the elderly.

- *Reduced first-pass metabolism:* Decreased hepatic extraction due to reduced liver perfusion increases the bioavailability of high first-pass drugs like propranolol, morphine, and verapamil, necessitating dose adjustments.
- *Topical and transdermal absorption*:
  - Aging skin becomes thinner with reduced blood flow, affecting the absorption of drugs from patches (e.g., fentanyl).
  - Elevated body temperature in febrile states can increase transdermal drug absorption, leading to potential toxicity.

Clinical Implications

- Drugs requiring active transport mechanisms, such as vitamin B12 and calcium, may have reduced absorption, leading to deficiencies.
- The increased bioavailability of certain drugs due to reduced first-pass metabolism necessitates careful dose adjustments to avoid toxicity.
- For drugs with delayed absorption, therapeutic monitoring may be needed to evaluate the timing and magnitude of the drug effect.

Table 8 outlines key physiological changes in drug absorption due to aging, providing examples of affected medications and their clinical consequences.

Distribution

Distribution refers to the movement of drugs from the bloodstream to tissues and organs. Age-related changes in body composition—such as increased fat, decreased water, and reduced lean body mass—can significantly alter drug distribution.

Key Changes in Distribution

- *Increased body fat:* Lipid-soluble drugs, such as diazepam, amiodarone, and propranolol, have a higher volume of distribution (Vd), leading to prolonged half-life and delayed drug elimination.
- *Decreased total body water:* Drugs that are water-soluble, such as aminoglycosides, digoxin, and ethanol, have a reduced Vd resulting in higher plasma concentrations and increased risk of toxicity.
- Reduced lean body mass: Medications such as digoxin, which is distributed to lean tissue, may accumulate at higher plasma levels increasing toxicity risk.
- *Serum protein binding:* Albumin, the primary binding protein for acidic drugs like warfarin and phenytoin, may decrease in malnourished or frail elderly patients, leading to increased free (active) drug levels.

TABLE 8: Age-related changes in drug absorption and their clinical implications.

Parameter	Age-related change	Examples	Clinical implications
Gastric pH	Increased	Calcium carbonate, iron, and ketoconazole	Reduced solubility of weakly acidic drugs
Gastric emptying	Slower	Paracetamol	Delayed onset of action
First-pass metabolism	Reduced hepatic extraction	Propranolol, morphine, and verapamil	Increased bioavailability

Alpha-1-acid glycoprotein, which binds basic drugs like propranolol and lidocaine, may increase during acute illness, temporarily altering drug binding dynamics.

Clinical Implications

- Lipophilic drugs accumulate in fat stores, increasing sedation and prolonging effects (e.g., benzodiazepines).
- Hydrophilic drugs show higher plasma concentrations, necessitating dose reductions to prevent toxicity.
- Close monitoring is required for protein-bound drugs to adjust for changes in free drug levels.

Table 9 highlights the effects of physiological changes in body composition and plasma protein levels on drug distribution in the elderly, illustrating examples and their clinical implications.

Metabolism

The liver is the primary site for drug metabolism, which involves converting drugs into active or inactive metabolites. Drug metabolism is classified into phase I (oxidation, reduction, and hydrolysis) and phase II (conjugation) reactions. Aging affects these pathways differently.

Key Changes in Metabolism:

- *Phase I metabolism*:
  - Phase I reactions mediated by cytochrome P450 enzymes (e.g., CYP1A2 and CYP2C19) decline with age, reducing the metabolism of drugs such as diazepam, theophylline, and amitriptyline.
  - CYP3A4 activity is variable and may remain unchanged or decline slightly.
- *Phase II metabolism:* Conjugation reactions (e.g., glucuronidation and sulfation) are generally preserved, making drugs like lorazepam and oxazepam safer options for elderly patients.
- *Hepatic blood flow*: Reduced hepatic blood flow decreases the clearance of drugs with high hepatic extraction ratios, such as propranolol, leading to prolonged drug half-lives.

Clinical Implications

- Drugs metabolized by phase I pathways (e.g., benzodiazepines) may require dose reductions due to prolonged clearance.

TABLE 9: Impact of age-related changes in drug distribution on pharmacokinetics.

Parameter	Age-related change	Examples	Clinical implications
Total body fat	Increased	Diazepam, amiodarone, and propranolol	Prolonged half-life of lipophilic drugs
Total body water	Decreased	Aminoglycosides, digoxin, and ethanol	Higher plasma concentrations
Serum albumin	Decreased	Warfarin and phenytoin	Increased free drug levels

TABLE 10: Age-related changes in hepatic metabolism and their clinical implications.

Parameter	Age-related change	Examples	Clinical implications
Phase I metabolism	Reduced CYP450 activity	Diazepam, theophylline, and amitriptyline	Prolonged clearance
Phase II metabolism	Unchanged	Lorazepam and oxazepam	Safer in elderly
Hepatic blood flow	Decreased	Propranolol	Prolonged half-life

- Drugs undergoing phase II metabolism are less affected by hepatic changes and are preferred in elderly patients.
- Frailty may further impair metabolic capacity, emphasizing the need for individualized drug dosing.

Table 10 summarizes how aging affects phase I and II metabolic pathways and hepatic blood flow, with examples of drugs impacted and their clinical consequences.

Excretion

Excretion is the removal of drugs from the body, primarily through the kidneys. Age-related decline in renal function is one of the most significant changes affecting pharmacokinetics in the elderly.

Key Changes in Renal Excretion

- *Decline in GFR:* GFR decreases by approximately 1% per year after the age of 40, leading to slower clearance of renally excreted drugs.
- *Reduced renal blood flow:* Renal perfusion declines by up to 50% by age 80, reducing the elimination of drugs like aminoglycosides and digoxin.
- *Tubular function:* Loss of tubular function impairs the reabsorption and secretion of drugs, increasing the risk of electrolyte imbalances and drug toxicity.
- *Serum creatinine misleading:* Reduced muscle mass leads to lower creatinine production, making serum creatinine levels appear "normal" even in the presence of significant renal impairment.

Clinical Implications

Renally excreted drugs (e.g., aminoglycosides, digoxin, and metformin) require dose adjustments based on estimated creatinine clearance (e.g., Cockcroft–Gault equation).

Monitoring renal function and serum drug levels is essential, especially for drugs with narrow therapeutic indices.

Table 11 outlines the effects of age-related renal function decline on drug clearance, highlighting examples of impacted drugs and the associated clinical risks.

Age-related changes in pharmacokinetics necessitate individualized drug selection, dose adjustments, and vigilant monitoring to optimize therapy and

TABLE 11: Age-related changes in renal excretion and their clinical implications

Parameter	Age-related change	Examples	Clinical implications
GFR	Declined by 25–50%	Digoxin, aminoglycosides, and metformin	Reduced clearance and drug accumulation
Renal blood flow	Decreased	NSAIDs	Increased risk of nephrotoxicity
Tubular function	Impaired	Diuretics	Risk of electrolyte imbalances

(GFR: glomerular filtration rate; NSAIDs: nonsteroidal anti-inflammatory drugs)

minimize adverse effects. By understanding the altered absorption, distribution, metabolism, and excretion of drugs in elderly patients, clinicians can ensure safer and more effective pharmacological management.

CLINICAL CASE SCENARIOS: PRACTICAL IMPLICATIONS OF AGE-RELATED CHANGES IN PHARMACOKINETICS

The following clinical case scenarios illustrate how age-related changes in PK (absorption, distribution, metabolism, and excretion) affect drug therapy in elderly patients. Each case demonstrates how these changes influence drug efficacy, safety, and clinical management.

Case 1: Absorption—Altered Gastric pH and First-pass Metabolism

Background

Mrs A, a 75-year-old woman, presents with fatigue and symptoms of anemia. She has a history of osteoporosis and has been taking calcium carbonate and iron supplements for several months without improvement in her symptoms. She also takes propranolol for hypertension.

Analysis

- *Absorption issues*:
  - *Increased gastric pH:* Mrs A's age-related hypochlorhydria (reduced gastric acid secretion) has likely reduced the absorption of calcium carbonate and iron, which require an acidic environment for optimal bioavailability.
  - *Reduced first-pass metabolism:* Propranolol, a high first-pass metabolism drug, may have increased bioavailability due to reduced liver perfusion, potentially resulting in lower BP and fatigue as side effects.

Management

- Switch from calcium carbonate to calcium citrate that is less dependent on gastric acid for absorption.
- Consider alternative formulations for iron supplementation, such as liquid preparations, or coadminister with vitamin C to enhance absorption.
- Monitor BP closely and reduce the propranolol dose if hypotension or fatigue persists.

ICP/API Guidelines on Rational Prescribing Practices in the Elderly

Salient Features

- **Comprehensive framework for rational prescribing:** The book emphasizes a structured and evidence-based approach to prescribing, tailored specifically for the elderly population. This includes detailed insights into age-related physiological and pharmacokinetic changes, as well as practical application of tools such as the Beers Criteria and STOPP/START frameworks to address potentially inappropriate medications (PIMs) and ensure safe and effective medication use.
- **Focus on polypharmacy management and deprescribing:** Addressing polypharmacy—a prevalent issue among older adults—the book provides strategies for mitigating its risks, such as adverse drug reactions (ADRs), medication nonadherence, and healthcare costs. It highlights deprescribing as a patient-centered intervention, using tools like comprehensive medication reviews (CMRs) to discontinue unnecessary or harmful medications.
- **Integration of personalized medicine and pharmacogenomics:** Personalized medication management is explored through precision medicine principles, integrating genetic predispositions, comorbidities, drug history, and functional status. The book demonstrates how pharmacogenomic insights, such as identifying genetic variations in drug-metabolizing enzymes, can reduce ADRs and enhance therapeutic outcomes in high-risk elderly populations.
- **Ethical and legal considerations in elderly care:** The book addresses the ethical complexities of prescribing for the elderly, including informed consent, shared decision-making, and end-of-life care. It stresses the importance of patient autonomy and collaborative care while ensuring compliance with legal and ethical standards in managing medications for vulnerable elderly patients.
- **Practical tools and real-world case studies:** The inclusion of case studies provides actionable insights into evidence-based prescribing practices. These examples illustrate managing challenges such as asymptomatic bacteriuria, drug-induced cognitive impairment, and ADRs in the context of polypharmacy. The book also explores innovative tools such as the anticholinergic burden scale to improve decision-making.

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