

LESSON 2-3

MEDICATION

Lesson: Medication

Authors: Zhanna Livshits, MD
Assistant Professor, Emergency Medicine & Medical Toxicology
Department of Medicine
New York Presbyterian/Weill Cornell Medical Center
New York, NY

Judith C. Ahronheim, MD, MSJ
Faculty Member, Bioethics Institute
Clinical Professor of Medicine
New York Medical College
Valhalla, NY

Intended Audience of Learners

A broad range of health professionals who may work with the older adult population.

Competencies

This lesson supports learning related to the following competencies, with regard to *medications related to conditions present in the geriatric population that impact their disaster preparedness, response, and recovery*:

Core Competencies and Subcompetencies from [Walsh L, Subbarao I, Gebbie K, et al. Core competencies for disaster medicine and public health. *Disaster Med Public Health Prep.* 2012;6\(1\):44-52. doi: 10.1001/dmp.2012.4.](#)

Core Competency 7.0 “Demonstrate knowledge of principles and practices for the clinical management of the geriatric population affected by disasters and public health emergencies, in accordance with professional scope of practice.”

Subcompetency 7.1 “Discuss potential physical and mental health consequences for all ages and populations affected by a disaster or public health emergency.”

Learning Objectives

At the end of this lesson, the learner will be able to:

- 2-3.1 List 5 or more risk factors that can lead to adverse drug events in the elderly.
- 2-3.2 List 3 or more symptoms that occur commonly in elderly patients that could be due to a medication.

Estimated Time to Complete This Lesson

90 minutes

Endorsement

NCDMPH does not endorse or recommend any commercial products, processes, or services. The views and opinions of authors expressed in this lesson do not necessarily state or reflect those of the U.S. Government, and they may not be used for advertising or product endorsement purposes.

Content Outline

Module 2: Conditions present in the older adult population that impact their disaster preparedness, response, and recovery

Lesson 2-3: Medication

I. Introduction

Medication prescribing, adherence, and achievement of desired clinical effects with minimal adverse reactions pose numerous challenges in the older adult population.

These challenges are greatly augmented in a community-wide disaster. Important factors to consider include:

- The number and complexity of medical conditions,
- Age-related changes in pharmacokinetics and pharmacodynamics,
- The number of prescribed and over-the-counter medications and the accompanying potential for drug interactions,
- Lack of prescriber knowledge of or experience in the principles of geriatric prescribing,
- Patient non adherence to a prescribed regimen,
- Clinical deterioration or even withdrawal symptoms following abrupt discontinuation of certain medications, and
- Unmasking of an illness following administration of particular medications.

II. Geriatric pharmacokinetic and pharmacodynamics principles¹

- Pharmacokinetics: how a drug gets in and out of the body
 - The absorption, distribution, metabolism, and excretion of medications
 - Drug entry from the gastrointestinal tract into the blood circulation
 - Distribution of drug in the body, including the “target organ” (intended site of action leading to intended effect) as well as nontarget organs (possible sites of action, sometimes leading to side effects)
 - Metabolism (change in structure and/or function of the drug molecule)
 - Elimination from the body

- Pharmacodynamics: the effect(s) of the drug on the body
- A. Important age-related pharmacokinetic changes:^{2,3}
 1. Renal (kidney) function:
 - Decline in kidney function, although not universal, is the most predictable factor affecting drug pharmacokinetics in the elderly.
 - Many drugs are excreted by the kidneys.
 - Age-related decline in the speed at which the kidneys eliminate substances in the urine (glomerular filtration rate) may cause slower elimination of the drug and, with repeated dosing, lead to drug accumulation and toxicity.
 - Blood tests to check kidney function, such as serum creatinine, are unreliable ways to determine kidney function in the elderly. Methods of rapid estimation of kidney function may be helpful; see Required Resources, Ahronheim et al, 2009 (Tool 4-3, page 78).
 - Patients have significantly enhanced risk for drug toxicity when taking medications that have a narrow therapeutic index.
 - Therapeutic index indicates the difference between the usual effective dose and the toxic dose of a drug. If the index is narrow, a slight change in dose may cause either lack of drug effect or severe toxicity. Careful clinical or laboratory monitoring may be required.
 - Some examples of medications with narrow therapeutic index include the following: digoxin, gentamicin, lithium, theophylline, and warfarin. For a more complete discussion, see Supplemental Resources (Ahronheim et al, 2015).
 2. Hepatic (liver) metabolism
 - Refers to modification or processing of a drug.
 - The liver is an important site for metabolism and detoxification of drugs within the body.
 - Not all drugs are modified by the liver, and some are eliminated unchanged in urine, bile, or feces.
 - Age-related factors may affect metabolism and detoxification, leading to drug accumulation and prolonged clinical effect.⁴
 - A person's genetic makeup, which is not related to age, may also affect metabolism.
 - Metabolism usually inactivates a drug, but for some drugs creates active components (metabolites) similar to the "parent" drug.
 - Example: Chlordiazepoxide, a sedative drug, is transformed to several active metabolites in the liver. This further contributes to drug accumulation and prolonged effects, such as over-sedation.

3. Body composition and where drugs reside

- The ratio of fat to lean tissue in the body increases with age.
- Fat-soluble (lipophilic) drugs accumulate in fat tissue; therefore, in the elderly, the peak effect of these drugs may occur later than expected, and their duration of effect may be prolonged.
- Example: Diazepam, a sedative drug similar to chlordiazepoxide, is a fat-soluble drug that may have longer duration of effects in geriatric patients because of its fat solubility (as well as presence of active metabolites).

B. Pharmacodynamic changes

- Responses to medications often change with aging, as physiologic and disease-related changes occur.
- Sensitivity to a particular drug often increases; in these cases, dose adjustment may be warranted, even if the drug is not eliminated more slowly with advancing age.
 - Example: Lorazepam, another sedative drug, is not eliminated more slowly in the elderly; however, geriatric patients have enhanced sensitivity to this drug (as to many sedating agents). Even small doses may produce adverse effects, such as confusion or excessive sedation.

III. Medication-related geriatric adverse events

Among adults, the incidence of adverse drug reactions increases with age, and is highest among people 80 years of age and older.⁵ Adverse drug events increase with the number of medications taken and may lead to hospitalization, morbidity, and mortality.⁶ The following factors contribute to adverse drug events in the elderly:⁷

A. Increase in number of medications (“polypharmacy”) and complexity of the medication regimen⁸

- Adherence to the drug regimen declines with increase in number of medications.⁹
- Dispensing changes at the time of prescription renewal, such as change from “brand name” to generic or change from one manufacturer to another, result in the new drug differing in color or shape from the familiar one.¹⁰
 - Example: A 72-year-old man was taking the antidepressant fluoxetine, an oblong green/white capsule. The renewed prescription was the generic fluoxetine, which looked like his cholesterol pill pravastatin. The patient wondered whether an error had taken place and did not take the fluoxetine until he was able to contact his mail-order pharmacy several days later.
- Change from immediate and modified-release drug formulations can alter the dose of drug ingested.

- Immediate-release formulations typically have a faster onset of action and shorter duration of effect than do modified release preparations.
 - The dosage and number of doses per day may differ.
 - Example: A 78-year-old woman was taking a controlled-delivery form of the antihypertensive diltiazem, a modified-release 360 mg tablet designed to be taken once daily, but she was given in error 360 mg of immediate release diltiazem. This resulted in a severe drop in blood pressure and slowed heart rate.
- B. Drug-drug interactions
- Drugs can interact with each other in the body, sometimes leading to problems.
 - Drug-drug interactions occur by diverse mechanisms, and the potential for interactions is very high when patients have a complicated drug regimen.
 - Not all interactions reach the level of clinical impact, but certain predictable interactions can be very dangerous.
 1. Warfarin interacts with many medications and even certain nutrients and herbal preparations. Examples include the following:
 - The antibiotics clarithromycin and ciprofloxacin¹¹ and the antacid medication cimetidine may impair the metabolism of warfarin and lead to bleeding.
 - St. John's Wort, an herbal preparation commonly used for depression, may stimulate the metabolism of warfarin and decrease its efficacy.
 - Taking warfarin and aspirin or clopidogrel concomitantly may increase the risk of serious bleeding, since each drug has the ability to prevent blood clotting.
 - These combinations may have important clinical use in certain circumstances but require careful monitoring.
 2. Digoxin, a cardiac drug, has numerous drug interactions that can lead to abnormal heart rhythms. Examples include the following:
 - Beta-blockers such as metoprolol and calcium channel blockers such as diltiazem and verapamil slow the heart and can have an additive effect with digoxin. (Refer to Table I for a list of commonly used beta- and calcium channel blockers.)
 - Verapamil and certain other noncardiac drugs also compete for the same mechanism of excretion (P-glycoprotein), leading to digoxin accumulation and toxicity.
 - A detailed review of drug and nutrient interactions can be found in Supplemental Resources (see Kleinshmidt, et al, 2011).
- C. Inappropriate prescribing practices¹² and predisposing factors

- Insufficient knowledge regarding pharmacokinetic and pharmacodynamics changes can result in poor choices of medication or lack of dose adjustment.
- Multiple providers, such as a general internist and one or more specialists, may prescribe conflicting medication to the same patient or may not communicate adequately with each other or with the primary care provider.
- Failure to anticipate risks of new drugs to elderly patients.
 - Inadequate numbers of geriatric patients and those with abnormal kidney function are enrolled in clinical trials prior to drug approval.^{13,14}
 - Unlike the context of a clinical trial, where subjects are carefully screened prior to randomization, elderly patients in practice often have comorbidities or various degrees of organ malfunction, putting them at enhanced risk of adverse effects.
 - Example: Dabigatran was approved after a successful clinical trial¹⁵ but within a short time an association with significant bleeding risk was found to exist in the clinical setting, with serious hemorrhage occurring, often in elderly patients.^{16,17} Research subjects with poor kidney function were underrepresented in the clinical trial. One would expect slowed elimination of dabigatran by the aged kidney. This example highlights how cautious prescribing of a new drug might prevent problems once the drug becomes available to sicker, older patients.

D. Transitions of care

- Adverse drug events occur during the time of transition of patient's care,¹⁸ such as discharge from hospital to home,¹⁹ or transition to long-term care facility from home or from hospital.
- Medication reconciliation, the process of verifying both newly prescribed medications and those that the patient is already taking, may decrease adverse drug events associated with transitions of care.²⁰

E. Unmasking

- Certain medications may unmask clinical conditions in geriatric patients. Examples include:
 1. Unmasking of dementia by medications such as diphenhydramine and cyclic antidepressants (e.g., amitriptyline), resulting in memory loss or confusion. These "anticholinergic" drugs interfere with acetylcholine, a transmitter system in the brain that may already be deranged in the earliest stages of dementia, even before the disease is clinically apparent.
 2. Unmasking of enlarged prostate ("Benign Prostatic Hypertrophy" or BPH) in a man by anticholinergic drugs, which lead to urinary retention and interfere with the bladder's ability to expel urine. Urinary retention, when severe, can cause extreme discomfort and even kidney damage.

F. Incautious prescribing of medications that have predictable adverse effects in the elderly²¹

- Criteria for potentially inappropriate medication use in the elderly have been developed to assist clinicians with prescribing safe medications for geriatric patients.^{21,22}
- Important examples of potentially inappropriate medications include the following:
 - Sedating antihistamines with anticholinergic properties (e.g., diphenhydramine and hydroxyzine)
 - Cyclic antidepressants with anticholinergic properties such as amitriptyline
 - Sedative drugs such as diazepam and lorazepam
 - Centrally acting muscle relaxants such cyclobenzaprine
 - See Required Resources, for a comprehensive list (American Geriatrics Society, 2012).

G. Pharmacologic management of conditions that are best managed nonpharmacologically

- Example: Mood stabilizers and/or sedatives (see Table I) are often given to manage agitation in patients with dementia. This should be avoided for two reasons:
 - (1) agitation in dementia is commonly caused by extrinsic factors, such as a patient's failure to recognize a person who is trying to feed or bathe him or her, or to pain or other causes of discomfort, and
 - (2) the medications that are selected can increase the risk of falls, delirium, confusion, and excessive sedation. In an emergency setting, sufficient personnel may not be available to calm or otherwise manage the patient, so assistance of family, friends, or other familiar caregivers should be encouraged.
- Note: This type of agitation differs clinically from delirium, which is caused by medical factors. In delirium, cautious pharmacologic management may be indicated after the underlying cause of delirium is sought and addressed.

H. Medication adherence

Medication adherence is important not only to treat an illness but also to prevent adverse consequences of medication withdrawal.

- Risk factors for nonadherence include the following:
 - Problems with memory,
 - Impaired vision,
 - Increase in number of medications,
 - Lack of understanding of how or why to take the medication(s),^{23,24,25} and

- Inability to pay for the medication(s).
- Strategies to promote medication adherence during a disaster
- Preparing at least a 1-week supply of medication for each geriatric patient is helpful in disaster preparedness.
 - If a medication is removed from the original bottle, labeling the new waterproof packet with the name of the drug, the name of the person, and dosing regimen may prevent potential dosing error.
 - Online pill identification tools may be useful for providers to identify pills that patients have in their possession.
 - See Supplemental Resources for comprehensive guidance on drug dosing and medication management for the elderly (Semla et al, 2013; Merck).

IV. Common medical conditions and treatment medications. The following is a limited list of medications used for these conditions (all are oral unless otherwise noted). This list may be used a reference for learner activities and learner assessment strategies (see sections below) and throughout the lesson. For a comprehensive source, see Supplemental Resources (Semla et al, 2014-2015 Reuben et al, 2014).

Table I. Common medical conditions and examples of treatment medications for older adults

- This table is intended for quick reference and use for learner activities related to disaster and nondisaster scenarios.
- Caveat: This is a partial list; inclusion on the list does NOT mean the drug is recommended in any particular case.
- Certain medications in the table are prescribed “off label,” i.e., used for a medical condition, age group, dosage, or route of administration (oral pill vs. injection) not approved by the Food and Drug Administration; a common example is the use of certain mood stabilizers for treatment of agitation in dementia.

Medical Condition	Commonly Used Medications
Hypertension (high blood pressure) <ul style="list-style-type: none"> • Medication aims to decrease elevated blood pressure to normal. • Some medications lower both blood pressure and 	Beta-adrenergic antagonist (beta-blockers): <ul style="list-style-type: none"> • Carvedilol • Metoprolol Calcium channel antagonists (calcium channel blockers): <ul style="list-style-type: none"> • Amlodipine

<p>heart rate and others just target the blood pressure.</p>	<ul style="list-style-type: none"> • Diltiazem • Nifedipine • Verapamil <p>Alpha-2 adrenergic antagonists (Alpha-2 blockers):</p> <ul style="list-style-type: none"> • Clonidine <p>Direct vasodilators (medications that directly relax the blood vessels):</p> <ul style="list-style-type: none"> • Hydralazine <p>Angiotensin-converting enzyme (ACE) inhibitors:</p> <ul style="list-style-type: none"> • Benazepril • Enalapril • Lisinopril <p>Angiotensin II receptor blockers (ARBs):</p> <ul style="list-style-type: none"> • Irbesartan • Losartan • Valsartan
<p>Dysrhythmia (abnormal heart rhythm)</p> <ul style="list-style-type: none"> • Medications either slow down the heart rate or aim to convert an abnormal rhythm into a normal heart rhythm. 	<ul style="list-style-type: none"> • Amiodarone • Beta-adrenergic antagonists • Calcium channel antagonists • Digoxin
<p>Anticoagulants (blood thinners that prevent blood clots):</p> <ul style="list-style-type: none"> • Often used to treat heart disease, blood clots, and stroke. 	<ul style="list-style-type: none"> • Warfarin • Apixaban • Dabigatran • Rivaroxaban
<p>Platelet inhibitors (interfere with formation of blood clots)</p> <ul style="list-style-type: none"> • Used to prevent stroke 	<ul style="list-style-type: none"> • Aspirin • Clopidogrel

or heart attack.	
<p>Congestive heart failure (CHF) and other fluid-retaining states:</p> <ul style="list-style-type: none"> • Medications aim to eliminate excess fluid from the body. 	<p>Diuretics (medications that enhance urinary elimination of salt and water):</p> <ul style="list-style-type: none"> • Bumetanide • Furosemide • Hydrochlorothiazide (HCTZ) • Spironolactone • Triamterene/HCTZ
<p>Diabetes mellitus (high blood sugar)</p> <ul style="list-style-type: none"> • Medications aim to maintain blood sugar in a normal range. 	<p>Hypoglycemic agents (medications that lower blood sugar)</p> <ul style="list-style-type: none"> • Glimepiride • Glipizide • Glyburide • Metformin • Pioglitazone • Repaglinide • Sitagliptin <p>Insulins (injection only):</p> <p>Rapid and ultra-short acting:</p> <ul style="list-style-type: none"> • Aspart • Lispro <p>Short-acting:</p> <ul style="list-style-type: none"> • Regular <p>Intermediate-acting:</p> <ul style="list-style-type: none"> • NPH <p>Long-acting:</p> <ul style="list-style-type: none"> • Glargine • Detemir
<p>Dementia</p> <ul style="list-style-type: none"> • Medications aim to slow loss of memory. 	<ul style="list-style-type: none"> • Donepezil • Memantine • Rivastigmine - primarily given as skin patch
Influenza	<ul style="list-style-type: none"> • Oseltamivir • Zanamivir
Depression	<ul style="list-style-type: none"> • Sertraline • Fluoxetine

	<ul style="list-style-type: none"> • Citalopram • Escitalopram • Bupropion
Hypothyroidism (underactive thyroid)	<ul style="list-style-type: none"> • Thyroxine
Insomnia	<ul style="list-style-type: none"> • Zolpidem • Temazepam • Trazadone
Mood stabilization	<ul style="list-style-type: none"> • Quetiapine • Haloperidol • Olanzapine • Risperidone • Valproic acid
Osteoarthritis	<p>Non-opioid (non-narcotic) pain control:</p> <ul style="list-style-type: none"> • Ibuprofen • Naproxen • Celecoxib • Acetaminophen <p>Opioid (narcotic) pain control:</p> <ul style="list-style-type: none"> • Codeine • Acetaminophen/Codeine • Morphine • Oxycodone and its modified release preparation • Oxycodone/Acetaminophen • Hydrocodone/Acetaminophen • Hydromorphone • Fentanyl (patch)

V. Inadvertent drug withdrawal

Abrupt cessation of daily therapeutic medications may lead to exacerbation of existing illness or clinical symptoms of withdrawal

- Access to medications during disaster may be challenging.
- Lack of adherence or lack of access may play a significant role in abrupt drug discontinuation.

- Certain prescription drugs, when chronically administered, are particularly relevant in geriatric practice because abrupt cessation may lead to serious or even life-threatening effects (see Table II).
- Substance abuse and subsequent withdrawal due to lack of access during disaster may present a diagnostic challenge in the elderly.
 - Substance abuse is less common in the elderly than among younger adults, but may be under recognized.
 - Alcohol (ethanol) is more commonly abused than illicit drugs.^{26,27}
 - Screening for alcohol misuse is important. CAGE and AUDIT (Alcohol Disorders Identification Test) are some of the traditional screening tools commonly used.^{28,29} ARPS (Alcohol-Related Problems Survey) may be a more sensitive screening tool in the elderly.³⁰

Table II. Medications associated with significant clinical effects following abrupt discontinuation after chronic use

Medication	Medical Use	Symptoms Seen if Drug Abruptly Discontinued
Anti-dementia agents	Dementia	Agitation, confusion
Levodopa/Carbidopa	Parkinson’s disease	Extreme rigidity
Sedatives	Anxiety, agitation, insomnia	Agitation, seizures
Clonidine	High blood pressure	Very elevated blood pressure
Opioids (narcotic pain medications)	Pain	Agitation, nausea, vomiting, sweating, abdominal cramping, diarrhea
Corticosteroids (such as prednisone)	Asthma, temporal arteritis and other autoimmune medical conditions	Weakness and fatigue, nausea and vomiting, severe drop in blood pressure (Addisonian crisis)
Antidepressants	Depression	Dizziness, exacerbation of depression, agitation

Suggested Learner Activities for Use in and Beyond the Classroom

Activity #1:

The instructor/educator will hand out several unidentified tablets. Medications can be selected from Table I.

The students will be divided in groups and identify the tablets.

- Students can use an on line pill identification resource

Activity #2: Agitation in dementia

The following scenarios will be discussed as a group.

1. An 82-year-old woman with Alzheimer's disease is admitted to the hospital for "control of agitation." Her agitation has been treated at home with lorazepam, trazodone, and olanzapine, but her symptoms have persisted. In the hospital she walks with a nursing assistant but is intermittently screaming. Haloperidol 1 mg is given intramuscularly without effect.

QUESTION: Why might a patient not respond to medications known to calm or even sedate? What lessons does this patient teach about agitation in the elderly? What is the next step?

Answer:

Clinicians often fail to address possible underlying causes of agitation on the assumption that agitation is an expected symptom of dementia. In this patient, a cursory physical examination revealed the patient lay calmly in bed until her left arm was moved, when she screamed in pain. She also was found to have a large mass in the left breast and left underarm. A review of her admission chest x-ray revealed a large lesion in her left humerus bone, suggestive of metastatic cancer. Further information indicated she has a history of breast cancer. Her agitation improved significantly when morphine was given. The sedating medications were tapered and her symptoms were controlled with oral morphine.

Screaming is not a typical manifestation of agitation in dementia; it is important to consider underlying causes of agitation, such as pain, discomfort from constipation, need for an immobilized patient to be repositioned or for restraints to be removed, and numerous other causes of discomfort that anyone could experience.

2. An elderly man with dementia has urinary incontinence. A nursing assistant comes to help him use the urinal and to clean him after an incontinence episode. He becomes agitated and pushes her away.

How would you manage this situation without resorting to sedating medications?

(Students may also wish to suggest possible scenarios for discussion, either hypothetical or from their own experience.)

Answer:

The staff need to avoid harm to themselves; however, a “stat” dose of medication is generally not the best, nor is it the only approach in this situation. In an elderly dementia patient, behavior that consists of resistance to basic treatments such as bathing, feeding, and toileting may be intermittent and short lived and may occur primarily when there is a new and unfamiliar caregiver. In this situation, nonpharmacological approaches are not only safer for the patient but reduce agitation more quickly than would the drug itself. Approaches include, among others, distraction/diversion or an alternate caregiver, family member, or other familiar person. For further information, see Supplemental Resources: National Institute on Aging; Alzheimer’s Association 2012).

Activity #3. Medication storage during disaster

Identify potential challenges to medication storage during disaster.

The group leader will facilitate discussion regarding potential pitfalls of medication mislabeling (pouring medication suspension into an unlabeled bottle), humidity leading to breakdown of medications, lack of refrigeration (especially insulin vials).

Activity #4: Strategies to avoid abrupt discontinuation of medications during disaster

The group will identify potential strategies to prevent abrupt discontinuation of medications.

- Have an up-to-date comprehensive list of medications and dosages in one specific location (e.g., wallet, refrigerator). Consider giving a copy of an updated list to a reliable family member, neighbor, or friend; avoid giving out multiple copies because medication regimens are often changed.

Readings and Resources for the Learner

- Required Resources
 - Ahronheim JC, Arquilla B, Greene RG, and the Geriatrics Disaster Preparedness Advisory Committee. Section 4: Medications: prescribing and dispensing. In: *Hospital Guidelines for Geriatric Preparedness*. New York City Department of Health and Mental Hygiene.
<http://www.nyc.gov/html/doh/downloads/pdf/bhpp/hepp-geriatrictoolkit-nov2009.pdf>. Published 2009. Accessed February 3, 2015.
 - American Geriatrics Society website. <http://www.americangeriatrics.org/>. Accessed February 2015.

- Beers E, Moerkerken DC, Leufkens HG, Egberts TC, Jansen PA. Participation of older people in preauthorization trials of recently approved medicines. *J Am GeriatrSoc.* 2014;62:1883-1890.
- Supplemental Resources
 - Ahronheim JC, Howland MA. Geriatric principles. In: Hoffman RS, Howland MA, Lewin LA, Nelson LS, Goldfrank LR, eds. *Goldfrank's Toxicologic Emergencies.* 10th ed. New York, NY: McGraw-Hill; 2015:428-436.
 - Kleinshmidt KC, Delaney KA. Biochemical and metabolic principles, appendix. In: Hoffman RS, Howland MA, Lewin LA, Nelson LS, Goldfrank LR, eds. *Goldfrank's Toxicologic Emergencies.* 10th ed. New York, NY: McGraw-Hill; 2015:168-170.
 - Communication and behavior problems: resources for Alzheimer's caregivers. National Institute on Aging. Alzheimer's disease education and referral center website. <http://www.nia.nih.gov/alzheimers/communication-and-behavior-problems-resources-alzheimers-caregivers#behavior>. Accessed February 3, 2015.
 - Behaviors: how to respond when dementia causes unpredictable behaviors. Alzheimer's Association website. https://www.alz.org/national/documents/brochure_behaviors.pdf. Published 2012. Accessed February 3, 2015.
 - Introduction to drug therapy in the elderly. The Merck Manual Professional Edition website. http://www.merckmanuals.com/professional/geriatrics/drug_therapy_in_the_elderly/introduction_to_drug_therapy_in_the_elderly.html. Reviewed June 2014. Accessed February 4, 2015.
 - Iyasere CA, Simmons LH, Fintelmann FJ, Dighe AS. Case 38-2014: an 87 year-old man with sore throat, hoarseness, fatigue, and dyspnea. *N Engl J Med.* 2014;371:2321-2327.
 - Reuben DB, Herr KA, Pacala JT, et al. *Geriatrics at Your Fingertips 2014.* American Geriatrics Society; 2014.

Learner Assessment Strategies

1. Engage learners in a group discussion or individual writing assignment related to the following questions.
 - a. What are 5 or more risk factors that can lead to adverse drug events in the elderly?
 - b. What are 3 or more symptoms that occur commonly in elderly patients that could be due to a medication?

Readings and Resources for the Educators

- Required Resources
 - Ahronheim JC, Arquilla B, Greene RG, and the Geriatrics Disaster Preparedness Advisory Committee. Section 4: Medications: prescribing and dispensing. In: *Hospital Guidelines for Geriatric Preparedness*. New York City Department of Health and Mental Hygiene.
<http://www.nyc.gov/html/doh/downloads/pdf/bhpp/hepp-geriatrictoolkit-nov2009.pdf>. Published 2009. Accessed February 3, 2015..
 - American Geriatrics Society. 2012 Beers Criteria Update. American Geriatrics Society updated Beers Criteria for potentially inappropriate medication use in older adults. *J Amer Geriatr Soc*. 2012;60:616-631.
 - Corsonello A, Pedone C, Incalzi RA. Age-related pharmacokinetic and pharmacodynamics changes and related risk of adverse drug reactions. *Curr Med Chem*. 2010;17:571-584. (alternative source: Cusack BJ. Pharmacokinetics in older persons. *Am J Geriatr Psychother*. 2004;2:274-302.)
- Supplemental Resources
 - Ahronheim JC, Howland MA. Geriatric principles. In: Hoffman RS, Howland MA, Lewin LA, Nelson LS, Goldfrank LR, eds. *Goldfrank's Toxicologic Emergencies*. 10th ed. New York, NY: McGraw-Hill; 2015:428-436.
 - Introduction to drug therapy in the elderly. The Merck Manual Professional Edition website.
http://www.merckmanuals.com/professional/geriatrics/drug_therapy_in_the_elderly/introduction_to_drug_therapy_in_the_elderly.html. Reviewed June 2014. Accessed February 4, 2015.
 - Iyasere CA, Simmons LH, Fintelmann FJ, Dighe AS. Case 38-2014: an 87 year-old man with sore throat, hoarseness, fatigue, and dyspnea. *N Engl J Med*. 2014;371:2321-2327.
 - Reuben DB, Herr KA, Pacala JT, Pollock BG, Potter JF, Semla TD, eds. *Geriatrics at Your Fingertips 2015*. American Geriatrics Society; 2015.
 - Semla TP, Beizer JL, Higbee MD, eds. *Geriatric Dosage Handbook*. 20th ed. Lexi-Comp; 2014-2015.

Sources Cited in Preparing Outline and Activities Above

1. Corsonello A, Pedone C, Incalzi RA. Age-related pharmacokinetic and pharmacodynamics changes and related risk of adverse drug reactions. *Curr Med Chem*. 2010;17:571-584.
2. Cusack BJ. Pharmacokinetics in older persons. *Am J Geriatr Psychother*. 2004;2:274-302.
3. Kinirons MT, Crome P. Clinical pharmacokinetics considerations in the elderly. An update. *Clin Pharmacokinet*. 1997;33:302-312.

4. Woodhouse KW, Wynne HA. Age-related changes in liver size and hepatic blood flow: the influence on drug metabolism in the elderly. *ClinPharmacokinet*. 1988;15:287-294.
5. Budnitz DS, Shehab N, Kegler SR, Richards CL. Medication use leading to emergency department visits for adverse drug events in older adults. *Ann Intern Med*. 2007;147:755-65.
6. Lau DT, Kasper JD, Potter DEB, Lyles A. Hospitalization and death associated with potentially inappropriate medication prescriptions among elderly nursing home residents. *Arch Intern Med*. 2005;165:68-74.
7. Hanlon JT, Semla TP, Schmader KE. Medication misadventures in older adults literature from 2013. *J Am Geriatr Soc*. 2014;62:1950-1953.
8. Hohl CM, Dankoff J, Colacone A, Afilalo M. Polypharmacy, adverse drug-related events, and potential adverse drug interactions in elderly patients presenting to an emergency department. *Ann Emerg Med*. 2001;38:666-671.
9. Gupta M, Agarwal M. Understanding medication errors in the elderly. *N Z Med J*. 2013;126:62-70.
10. Kesselheim AS, Bykov K, Avorn J, Tong A, Doherty M, Choudhry NK. Burden of changes in pill appearance for patients receiving generic cardiovascular medications after myocardial infarction: cohort and nested case-control studies. *Ann Intern Med*. 2014;161:96-103.
11. Ghaswalla PK, Harpe SE, Tassone D, Slattum PW. Warfarin-antibiotic interactions in older adults of an outpatient anticoagulant clinic. *Am J Geriatr Pharmacother*. 2012;10:352-360.
12. Ferry ME, Lamy PP, Becker LA. Physician's lack of knowledge of prescribing of the elderly: a study in primary care physicians in Pennsylvania. *J Am Geriatr Soc*. 1985;33:616-625.
13. Beers E, Moerkerken DC, Leufkens HG, Egberts TC, Jansen PA. Participation of older people in preauthorization trials of recently approved medicines. *J Am Geriatr Soc*. 2014; 62:1883-1890.
14. Bugeja G, Kumar A, Banerjee AK. Exclusion of elderly people from clinical research: a descriptive study of published reports. *BMJ*. 1997;315:1059.
15. Connolly SJ, Ezekowitz MD, Yusuf S, et al; RE-LY Steering Committee and Investigators. Dabigatran versus warfarin in patients with atrial fibrillation. *N Engl J Med*. 2009;361:1139-1151. [Erratum: *N Engl J Med*. 2010;363:1875.]
16. FDA drug safety communication: update on the risk for serious bleeding events with anticoagulant Pradaxa (dabigatran). US Food and Drug Administration website. <http://www.fda.gov/Drugs/DrugSafety/ucm326580.htm>. Published November 2, 2012. Accessed December 3, 2014.
17. Southworth MR, Reichman ME, Unger EF. Dabigatran and postmarketing reports of bleeding. *N Engl J Med*. 2013;368:1272-1274.

18. Desai R, Williams CE, Greene SB, Pierson S, Hansen RA. Medication errors during patient transitions into nursing homes: characteristics and association with patient harm. *Am J Geriatr Pharmacother.* 2011;9:413-422.
19. Armor BL, Wight AJ, Carter SM. Evaluation of adverse drug events and medication discrepancies in transitions of care between hospital discharge and primary care follow-up. *J Pharm Pract.* 2014;Oct 13 [Epub ahead of print].
20. Schnipper JL, Hamann C, Ndumele CD, et al. Effect of electronic medication reconciliation application and process redesign on potential adverse drug events: a cluster-randomized trial. *Arch Intern Med.* 2009;169:771-780.
21. American Geriatrics Society. 2012 Beers Criteria Update. American Geriatrics Society updated Beers Criteria for potentially inappropriate medication use in older adults. *J Am Geriatr Soc.* 2012;60:616-631.
22. Gillespie U, Alassaad A, Hammarlund-Udenaes M, et al. Effects of pharmacists interventions on appropriateness of prescribing and evaluation of the instruments' (MAI, STOPP and STARTS') ability to predict hospitalization--analyses from a randomized controlled trial. *PLOS One.* 2013;8:e62401.
23. Hayes TL, Larimer N, Adami A, Kaye A. Medications adherence in healthy elders: small cognitive changes make a big difference. *J Aging Health.* 2009;21:567-580.
24. Pasina L, Brucato AL, Falcone C. Medication non-adherence among elderly newly discharged and receiving polypharmacy. *Drugs Aging.* 2014;31:283-289.
25. Smith M, Bailey T. Identifying solutions to medication adherence in the visually impaired elderly. *Consult Pharm.* 2014;29:131-134.
26. Fink A, Hays RD, Moore AA, Beck JC. Alcohol-related problems in older persons: determinants, consequences and screening. *Arch Intern Med.* 1996;156:1150-1156.
27. Kuerbis A, Sacco P, Blazer DG, Moore AA. Substance abuse among older adults. *Clin Geriatr Med.* 2014;30:629-654.
28. National Institute on Alcohol Abuse and Alcoholism. AUDIT questionnaire. <http://pubs.niaaa.nih.gov/publications/Audit.pdf>. Accessed December 8, 2014.
29. National Institute on Alcohol Abuse and Alcoholism. CAGE questionnaire. <http://pubs.niaaa.nih.gov/publications/inscage.htm>. Accessed December 8th, 2014.
30. Culberson JW. Alcohol use in the elderly: beyond the CAGE. Part 2: Screening instruments and treatment strategies. *Geriatrics.* 2006;61:20-26.