

The Basics in HIV:

What Every Pharmacist Should Know

Part 2: Medication Errors, Drug Interactions, Adherence & Resistance

Learning Objectives

1. Identify situations leading to medication errors with antiretroviral prescriptions
2. Recognize how drug interactions and adherence impact the development of resistance
3. List the various sources of funding for persons living with HIV/AIDS

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Table 1: Common Causes of Medication Errors

Patient misuse (poor understanding)
Poor communication
Ambiguity in name, directions and abbreviations
Poor procedures/technique
Job stress, lack of product knowledge and training

Medication errors involving antiretrovirals have been extensively reported in literature. In the hospital setting, a range of 5.8 to 100 percent of admitted HIV positive patients prescribed antiretrovirals had experienced a medication error.^{2,6} Others determined 21-23 percent of antiretrovirals prescriptions had errors.^{7,8} One study describes 400 antiretroviral medication errors reported to a national medication error reporting program (MED-MARX®), between January 2000 and December 2003. Errors were reported from community hospitals (50%), university teaching hospitals (34%), other settings (7%) and not indicated (9%). Of the 400 reported errors, 45 percent occurred during the dispensing phase of the medication order process and 49 percent reached the patient, with 3 percent considered harmful. The most common type of error was wrong dose at 37 percent and wrong medication at 32 percent.⁹ Table 1 outlines situations that may lead to medication errors.¹⁰ Quality or process improvement initiatives may decrease these risks for errors. Types of medication errors are listed in Table 2.

Misuse of HAART due to poor understanding of medication directions or general HIV knowledge will lead to the development of

Table 2: Types of Medication Errors

- Wrong drug
- Wrong dose
- Wrong frequency
- Wrong administration time
- Missing drug/information
- Drug interactions

errors, which may result in more severe consequences. To avoid this misuse, patient counseling and education of HAART are needed. Reviewing the basics of HIV should include how it damages the immune system, goals of therapy and how HAART will aid in viral suppression. Therapy, if dosed twice daily, should be given q12h to provide adequate concentrations throughout the dosing period. Patients often think a medication is taken with food to decrease gastrointestinal symptoms; however, patients also need to understand that food is required with certain antiretrovirals for adequate drug absorption. Finally, adherence to HAART, as combination therapy, should be stressed. To allow for adequate drug concentrations, all drugs need to be taken the same time daily to prevent the development of resistance.

Poor communication between the provider and the pharmacy regarding medications commonly occur with verbal prescriptions. Inability to provide patient counseling due to language barriers also contribute to the patient's lack of understanding of their regimen. Often when providers change HAART regimens, the previous antiretroviral medications are not discontinued. Often patients request all of their antiretrovirals, only to receive both their current and previous regimens. In receiving both of these regimens, there is potential duplication of therapy (e.g., lamivudine and emtricitabine), which may lead to toxicity or drug interactions.

Miscommunication of antiretrovirals with ambiguous names will lead to errors. For example, the abbreviation of "AZT" may be misinterpreted as zidovudine, aztreonam or azathioprine.¹¹ The directions of "take three

The role of the pharmacist in the care of a person living with HIV/AIDS (PLWHA) is paramount. It is clear that pharmacists who actively manage drug therapy can improve patient outcomes. For a PLWHA, the relationship with their pharmacist is important to aid in adherence and to review drug profiles for potential drug interactions to prevent the development of resistance. This second article will focus on these aspects of care in preventing medication errors and working with the patient to address barriers to adherence to their highly active antiretroviral therapy (HAART).

Medication Errors

HIV therapy today consists of not only antiretrovirals, but may also include medications for prophylaxis or treatment of opportunistic infections, side effect management, alternative or herbal supplements and treatment of comorbidities. With the potential for polypharmacy, the risk of medication errors is high. As always, pharmacists need to be vigilant in detecting these medication errors, as the consequences may be detrimental.

The Institute of Medicine defines a medication error as, "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient or consumer. Such events may be related to professional practice, health care products, procedures and systems, including prescribing; order communication; product labeling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use."¹

Table 3: Look Alike & Sound Alike Medications Involving Antiretrovirals

Retrovir®	Ritonavir
Nelfinavir	Nevirapine
Viracept®	Viramune®
Invirase®	Efavirenz
Lamivudine	Terbinafine
Lamivudine	Lamotrigine
Lamivudine	Ranitidine
Nelfinavir	Nefazodone
Zerit®	Zyrtec®
Combivir®	Trizivir®
Zidovudine	Zovirax®
Isentress®	Intelence®
Norvir®	Norvasc®
Saquinavir	Sevelamer
Zidovudine	Zonisamide
Zidovudine	Ziprasidone
Videx®	Vioxx®
Didanosine	Didronel®
Viramune®	Vitamin E
Lexiva®	Levitra®/Lexapro®
Combivir®	Combivent®
Saquinavir	Sinequan®
Viread®	Viramune® or Viracept®

Gray J et al. *AIDS Patient Care and STDs* 2005;19:803-12.
Fargon J et al. *AIDS Read* 2003;13:268-80

tablets daily” may be misinterpreted by the patient to take one tablet three times a day. Reformulations of existing antiretrovirals often lead to dosing errors. When atazanavir was approved at 300 mg po once daily, two of the 150 mg capsules were used. When the new formulation of 300 mg was developed, many patients had inadvertently taken two of the 300 mg capsules, leading to higher concentrations of atazanavir. This also occurred with lopinavir/ritonavir 133.3/33.3 mg capsules and 200/50 mg tablets, efavirenz 200 mg capsules and 600 mg tablets, and darunavir 300 mg tablets and 600 mg tablets. Table 3 lists the ambiguity in medications involving antiretrovirals.^{9,12}

Any poor procedures involving antiretrovirals or lack of standardized procedures in prescription ordering or order verification may also lead to errors. In the health-system setting, some hospitals use standardized order sets listing antiretrovirals and their doses. Similar order sets also may be utilized in the community setting. Because of these specialized medications, there may be certain trained staff permitted to fill and dispense antiretrovirals. Some pharmacies may elect to have all antiretroviral agents in their inventory or track their patient’s monthly

need for antiretrovirals to avoid any interruption in therapy.

Commonly, lack of knowledge or training of HIV and antiretrovirals lead to errors made by the pharmacy staff. Infrequent prescriptions also lead to errors. There are often higher expectations of the front-line staff from management for productivity, leading to stressful environments and the potential of medication errors. There is limited time spent with patients as pharmacists are working longer hours, filling more prescriptions and reducing services due to vacant positions.¹³ In North Carolina, 59 percent of community pharmacists indicate that there was not enough time to provide adherence counseling on antiretrovirals.¹⁴ With the specialty area of HIV medicine, it is not a common topic for continuing education, nor are pharmacists adequately trained in this area. It was noted that insufficient education and training to provide effective HIV medication counseling was a barrier for pharmacists in the community setting.¹⁵

With increasingly new cases of HIV, and recommendations for earlier treatment, more antiretrovirals are being prescribed and processed through various pharmacy settings. Community pharmacists will need to stay current in maintaining their knowledge of HIV medicine to provide proper antiretroviral counseling. Health care organizations will need to standardize antiretroviral order processing and maintain current references and education for the pharmacy staff.

Drug Interactions

As medication experts, pharmacists are responsible in reviewing medication profiles to address potential or actual drug interactions. Antiretrovirals may interact with each other as well as with non-antiretrovirals, over-the-counter medications and herbal supplements. Consequences of the interactions are toxicity or decreased efficacy of antiretrovirals or the concomitant drug. With the potential for multiple drug interactions, a pharmacist should always spend the extra time in reviewing these profiles.

The PIs, NNRTIs and CCR5 inhibitor are antiretrovirals that inhibit or induce hepatic metabolism involving the cytochrome P450 (CYP450) enzyme system, particularly CYP3A4. All PIs are CYP3A4 substrates, and therefore, their concentrations may be decreased with inducers or increased with 3A4 inhibitors. All PIs are also inhibitors of 3A4. In addition, fosamprenavir is also an inducer of 3A4; nelfinavir exists as a substrate of 2C19; ritonavir is a substrate and inhibitor of 2D6; and tipranavir/ritonavir is an inhibitor

Table 4: Commonly Used Agents Causing Drug Interactions with PIs, NNRTIs, CCR5 Inhibitors

- **Cardiac Agents**
 - Amiodarone, Flecainide, Propafenone, Quinidine, Digoxin
 - Calcium Channel Blockers, Diltiazem
- **Hormonal Contraceptives**
- **HMG CoA Reductase Inhibitors**
 - Simvastatin, lovastatin, atorvastatin, pravastatin*, rosuvastatin*
- **Antimicrobials**
 - Clarithromycin
 - Rifampin, rifabutin
- **Benzodiazepines**
 - Midazolam, triazolam
- **Ergot Alkaloids**
- **Herbal Supplements**
- **Fluticasone**
- **Proton Pump Inhibitors***
- **Anticonvulsants**
 - Carbamazepine, phenytoin, phenobarbital, valproic acid
- **Antifungals**
 - Itraconazole, voriconazole, ketoconazole
- **Methadone, propoxyphene**
- **Phosphodiesterase Type 5 Inhibitors**
- **Warfarin**
- **Cisapride**
- **Pimozide**

*Drug specific Panel on Antiretroviral Guidelines for Adults and Adolescents. *Guidelines for the use of antiretroviral agents in HIV-1 infected adults and adolescents*. Department of Health and Human Services. Dec. 1, 2009; 1-161. Available at www.aidsinfo.nih.gov/ContentFiles/AdultandAdolescentGL.pdf. Accessed 2/4/10 [p1-168].

of 2D6.¹⁶ A common interaction that may occur in the hospital setting involving protease inhibitors is the prescribing of a proton pump inhibitor (PPI) for stress ulcer prophylaxis in a patient receiving atazanavir. Depending on the patient’s antiretroviral history, the nearly automatic prescribing of a PPI may cause reduced concentrations of atazanavir, leading to the emergence of resistant virus. Another common interaction is the automatic substitution of lipid lowering agents such as simvastatin or lovastatin, which are contraindicated with PIs.

NNRTIs are also metabolized by 3A4 and may act as inducers (nevirapine), inhibitors (delavirdine) or mixed (efavirenz, etravirine). Etravirine is unique, as it is a substrate of 3A4, 2C9 and 2C19, an inducer of 3A4 and an inhibitor of 2C9 and 2C19.^{17,20}

The CCR5, maraviroc (MVC) is a substrate

Table 5: Antiretroviral Drug Interaction Web Sites

- [www.aidsinfo.nih.gov/guidelines/DHHS treatment guidelines](http://www.aidsinfo.nih.gov/guidelines/DHHS_treatment_guidelines)
- <http://hivinsite.ucsf.edu>
 - Database of Antiretroviral Drug Interactions
- www.hopkins-aids.edu
 - Registration
- www.hiv-druginteractions.org
 - University of Liverpool
- <http://medicine.iupui.edu/clinpharm/ddis/> – CYP450 interaction charts
- www.hivpharmacology.com
 - Registration
- www.aidsmeds.com
 - Patient-targeted Web site
- <http://hiv.buffalo.edu>
 - Updates on drug interactions

of CYP450 3A4, and thus is subject to many drug interactions, leading to dose adjustment of MVC. Maraviroc is not an inducer or inhibitor of CYP450 system. Table 4 outlines common drug interactions with PIs, NNRTIs and CCR5 inhibitors.²¹

The NRTIs and fusion inhibitor are not hepatically metabolized by the CYP450 enzyme pathway.^{16,22} Drug interactions have been reported with specific NRTIs; although many are not clinically significant, others may lead to toxicity. Didanosine (ddI) toxicities must be monitored when combined with valganciclovir, ribavirin and allopurinol. As ddI's absorption is pH dependent, it must be administered without food. Special consideration is needed when the drug is combined with other antiretrovirals that require food for absorption.²³ Zidovudine toxicities must be monitored when given with other agents that have myelosuppressive characteristics, such as ganciclovir/valganciclovir, interferon alpha, ribavirin or cytotoxic drugs. Zidovudine should not be given with stavudine due to antagonistic effects.²⁴ Tenofovir (TDF) when combined with ddI leads to increased ddI AUC and Cmax of 48-60 percent. A dose reduction of ddI is required when combined with TDF (>60 kg: ddI 250 mg, <60 kg: ddI 200 mg).²³ Enfuvirtide, as a peptide, is catabolized into its amino acid constituents. As such, enfuvirtide is not a substrate, inhibitor or inducer of the CYP450 pathways and no clinically relevant drug interactions have been reported.²²

The integrase inhibitor, raltegravir, is a substrate of UDP-glucuronosyltransferase (UGT1A1) enzyme pathway. Inhibitors of this pathway, including atazanavir, may increase

raltegravir concentrations. Inducers such as efavirenz, tipranavir and rifampin or rifabutin may decrease raltegravir concentrations affecting efficacy and potentially leading to viral resistance to raltegravir. As a new agent, frequent monitoring of the medical literature of potential drug interactions with raltegravir is recommended.²⁵

Pharmacokinetic Boosting

Ritonavir is a potent CYP450 3A4 inhibitor. As such, it is commonly used at a lower dose of 100-200 mg q12h for daily doses ranging from 100-400 mg to increase or "boost" the trough concentrations of the other protease inhibitor, allowing for higher trough concentrations to provide an increased barrier to resistance. In addition, the higher concentrations allow for increased half-lives, leading to decreased frequency of dosing.¹⁶

Drug interactions occur between antiretrovirals and herbal supplements. St. John's wort²⁶ and Echinacea²⁷ are both inducers of 3A4, thus interfering with maraviroc, NNRTIs and PIs. Garlic supplements have been shown to interact with unboosted saquinavir soft gel capsules. After a 10-day washout, pharmacokinetic values returned to 60-70 percent of baseline.²⁸ The effects of boosted PIs with garlic supplementation, however, is unknown. Ginkgo biloba extract induces CYP3A metabolism. No change in lopinavir exposure was found, likely due to the potent inhibition of 3A4 from ritonavir. Study conclusions state Ginkgo was unlikely to reduce exposure of boosted PIs; however, other 3A4 substrates such as NNRTIs may be affected.²⁹ This will likely affect maraviroc concentrations as well.

A broad recommendation in determining drug interactions with antiretrovirals is to first use a general drug database. If a drug interaction is not reported, it is then important to determine how the drug in question is metabolized. This is to ascertain hypothetical drug interactions with the antiretroviral. Drug interactions are continuously reported as case reports or a case series with proposed mechanism of interactions. Therefore, it is important to clarify any unknown information, or at least determine if a hypothetical drug interaction may exist, and adjust the dose accordingly. The Department of Health and Human Services HIV guidelines have extensive tables outlining the drug-drug interactions with antiretrovirals.¹⁶ Table 5 lists various antiretroviral drug interactions Web sites. As a general statement regarding drug interactions, the lack of reported information does not negate the presence of an interaction.

Table 6: Strategies to Improve Adherence

- Utilize a multidisciplinary approach
- Establish a trusting relationship
- Establish readiness to start HAART
- Identify potential barriers to adherence prior to starting HAART
- Provide resources for the patient
- Involve the patient in HAART selection
- Assess adherence at every clinic visit
- Identify the type and reasons for nonadherence
- Assess and simplify regimen, if possible

Table 7: Tips for Adherence

- Pill boxes
- Printed schedule
- Alarms: pagers, timers, watches and cell phones
- Visual cues
- Support of family and friends
- Color pictures of set up pill box
- Pharmacies with medication programs
- Medication trial
- Store boiled water, snacks at work/car
- Water by bed, for privacy
- Post-It notes
- Medication schedule on fridge door
- Place meds by or link medications to a daily activity
- Carry a spare or extra dose

Adherence to Antiretrovirals

Adherence, different from compliance, is the patient behavior coinciding with an agreed therapeutic regimen as determined by a shared decision-making process.³⁰ As nonadherence is ubiquitous in medicine, focus should be placed on the PLWHA addressing any barriers to adherence, as it is the single most important factor in achieving viral suppression.^{31,33} Adherence to antiretrovirals has been shown to correlate with positive outcomes of a better quality of life, increased survival and control of HIV.^{34,35}

Barriers to adherence in antiretrovirals include, but are not limited to, adverse drug reactions, lack of insurance, inability to afford co-pays, lack of transportation, difficulty in accepting their HIV diagnosis, active substance abuse, low functional literacy, inability to navigate the health care system, homelessness, complex regimens, treatment fatigue and chaotic lifestyle or living situation. Table 6 and 7 address various strategies for the patient to overcome barriers to adherence.

Factors that have been described to be

elements for success in adherence include:³⁶

- 1) Program: HIV clinic, AIDS Service Organization or the case management agency, which are accessible with sufficient resources to help PLWHA
- 2) Provider: Health care professional who is an expert and trained in HIV with interpersonal skills
- 3) Regimen: Simple, durable, potent, tolerable and high resistance barrier
- 4) Patient: Stable housing, transportation, insurance and social support

Adherence to antiretrovirals is paramount, as delayed doses or missed doses lead to reduced antiretroviral concentrations, predisposing the patient to the development of viral resistance. The use of a multidisciplinary team addressing adherence is common. Many PLWHA living in Michigan have HIV case managers who are certified and trained in medication adherence by the HIV Continuum of Care Unit of the HIV/AIDS Prevention & Intervention Section at the Michigan Department of Community of Health (MDCH).

HIV Resistance

As the virus replicates within the body, it is a highly dynamic process, as HIV is produced and destroyed on a daily basis. There is estimated to be 1,010 virions produced daily, each with a half-life of approximately 30 minutes.³⁷ The production of virus, as determined by the viral load, is the net difference of HIV production and clearance. The infected CD4 cells have only a half-life of approximately 0.7 days,³⁷ thus the collection of CD4 in the body reflects the constant infection of new cells. HIV is also known to be error prone during its rapid replication cycle, particularly during reverse transcription. During this process, reverse transcriptase (RT) generates errors, with a rate of one incorrect nucleotide in 17,000 to 30,000 nucleotides.³⁸ These multiple errors then translate or code to alternate amino acid substitutions, creating a mutation in the viral genome.

With a high replication rate and multiple errors in the amino acid coding of HIV proteins, the resultant diverse viral population is also known as quasispecies. These variant strains, along with strains developed from selective drug pressure, affect future treatment options. Drug resistant virus emerges in the presence of drug concentrations that are insufficient to suppress viral replication but sufficient enough to wield a positive selective pressure on a viral strain.³⁹ It is this drug resistant viral population that may be transmitted, leading to potential limitation of

treatment options in a newly infected person. Figure 1 shows the types of drug resistance.

The development of mutations occurs in viral enzymes, such as reverse transcriptase, integrase or protease or on the structural binding sites for enfuvirtide,³⁹ or maraviroc.⁴⁰ With the amino acid substitutions in each of these areas, drugs with a low genetic barrier to resistance may become resistant with the presence of only one mutation. However, drugs with higher genetic barriers will require multiple mutations to decrease susceptibility and lead to resistance. Depending on the mutation that arises from subtherapeutic drug concentrations, cross resistance may also occur with other antiretroviral agents,³⁹ again limiting treatment options for the patient.

The foremost concern regarding resistance is the development of multidrug resistant virus. With a limited number of commercially available antiretrovirals, any resistance developed or acquired through transmission will reduce the number of antiretroviral choices in creating HAART regimens. Figure 2 illustrates the pattern of transmitted drug resistance from 1998 to 2007, as reported by the Centers for Disease Control and Prevention (CDC).^{41,43} Although small, the rates of multidrug resistant (MDR) virus are increasing, leading to concern for many providers.

The State of Michigan participates in a CDC funded surveillance program to determine HIV resistance as part of routine diagnostic procedures. Since October 2004, the state laboratory has tested more than 800 newly diagnosed PLWHA to determine the rate of drug resistance in Michigan. Approximately one in seven individuals are infected with a drug resistant strain, and approximately one in 15 are infected with a multidrug resistant strain.⁴⁴

Factors other than nonadherence and drug interactions that may lead to the emergence of resistance include pharmacokinetic issues, such as decreased absorption or increased clearance of the drug from the body. It is for these reasons that the role of the pharmacist in the care of a PLWHA is crucial. As the most accessible health care provider, a pharmacist can encourage and address adherence barriers, resolve drug interactions and provide complete antiretroviral education to ensure adequate drug concentrations in preventing development of HIV resistance.

Resistance Testing

Genotypic and phenotypic assays are used to detect viral resistance and to determine the approach in treatment. Genotype assays provide the viral mutations based on the sequencing of the reverse transcriptase and

protease and integrase genes. Interpretation of the mutations is required to determine susceptibility to antiretrovirals. Phenotypes assays measure the ability of the patient's virus to grow in various concentrations of drug. This test is more expensive and results require a longer time of two to three weeks for processing compared to genotypes, which typically take one to two weeks.¹⁶ Virtual phenotypes are also available for clinicians to determine next regimens. This test, utilizing a database of matched genotypes and phenotypes, provides information on predicted phenotypes based on the genotype data.⁴⁵

The following guidelines outline when resistance testing should be performed:¹⁶

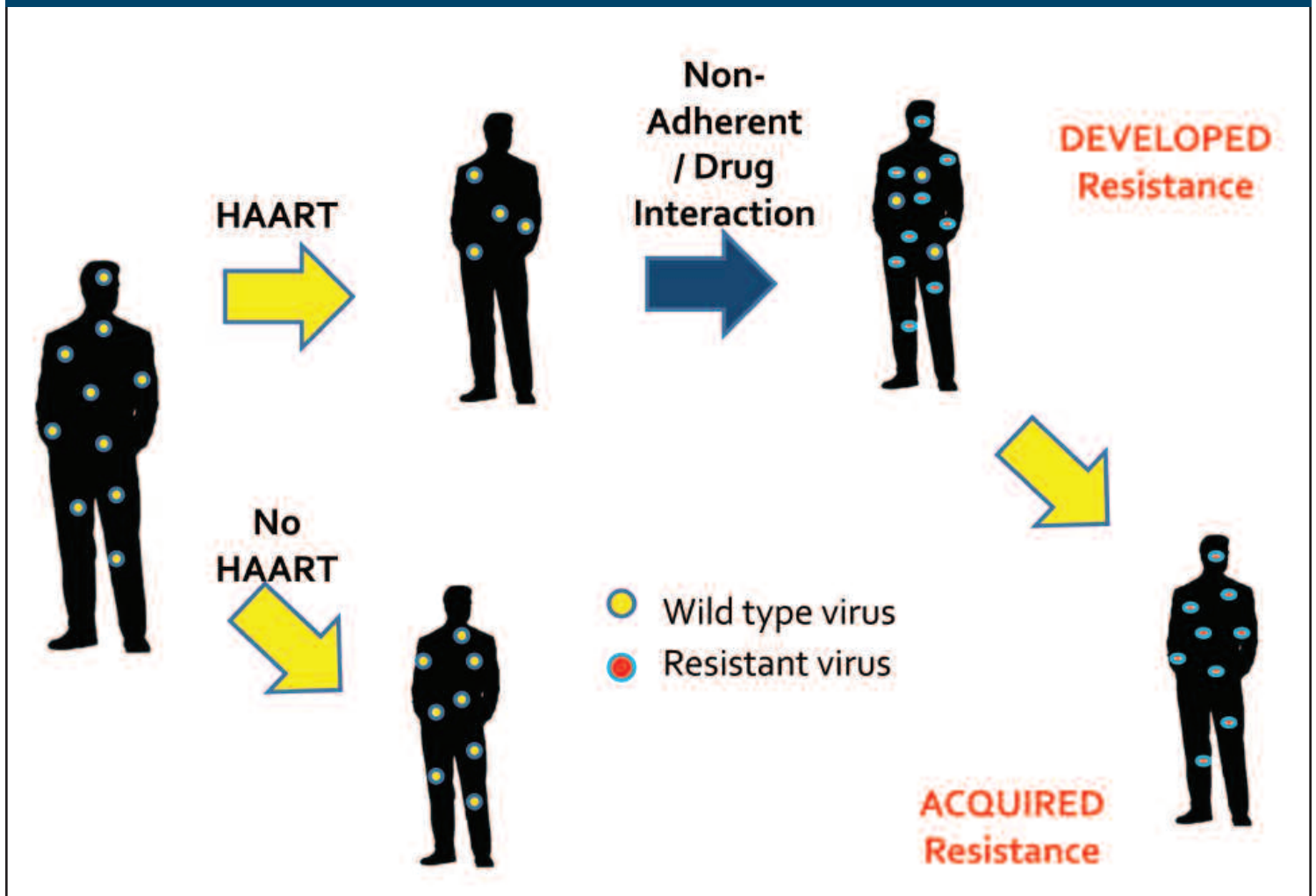
- Acute HIV infection or seroconversion regardless of treatment plans, to determine any transmitted resistance
- Treatment-naïve patients with chronic infection at the time of entry into care, regardless of treatment
- Pregnancy to determine best available HAART to prevent vertical transmission
- Patients with virological failure while receiving HAART with viral loads >1,000 copies/mL. Resistance testing should always be performed while the patient is taking antiretrovirals. If this is not possible, it should be performed within four weeks of discontinuation
- Patients with suboptimal suppression after initiating HAART to determine the active drugs for the regimen

Funding for PLWHA

The Ryan White CARE (Comprehensive AIDS Resources Emergency) Act was a bill passed by Congress in 1990 that provides health care coverage, financial resources or fills gaps in care not covered by other sources for PLWHA. This program has been reauthorized multiple times and is now called the Ryan White HIV/AIDS Program. Currently funded at \$2.1 billion, this program is administered by the U.S. Department of Health and Human Services (DHHS), Health Resources and Services Administration (HRSA) and HIV/AIDS Bureau (HAB). Granted funds are distributed to various programs or parts. The parts include:

- Part A: Eligible Metropolitan Areas (EMA) that are most severely affected
- Part B: State health departments
- Part C: HIV clinics
- Part D: Programs for family-centered care with women and children with HIV/AIDS
- Part F: Programs include Special Projects of National Significance, AIDS education

Figure 1: Types of Resistance



and training Centers, dental programs and Minority AIDS Initiative.⁴⁶

In 2008, \$28 million was granted to various programs in Michigan. Approximately \$8 million was provided to the Detroit area as an EMA, \$17 million to HIV/AIDS Prevention & Intervention Section (HAPIS) of the Division of Health, Wellness and Disease Control at MDCH and \$2.7 million was directly funded to HIV clinics to provide comprehensive primary HIV care services.⁴⁷

The AIDS Drug Assistance Program (ADAP) is administered by the HIV Continuum of Care Unit of HAPIS. While not considered insurance, it does provide coverage of selected prescription medications for eligible PLWHA.⁴⁸ Eligibility criteria vary per state, as does the list of prescription drugs. With the increased number of newly diagnosed individuals due to testing efforts and changes in treatment guidelines with earlier HAART initiation, more patients are in need for prescription coverage. In a

recent press release from the National Alliance of State and Territorial AIDS Directors (NAS-TAD), there are currently 1,000 individuals in 10 states that are on a wait list to receive antiretrovirals. This number has increased from last year in May 2009 of 99 individuals.⁴⁹ Four additional states are now considering a wait list and another five are considering a reduced formulary or stricter eligibility.⁵⁰ With initial HAART regimen cost ranging from \$1,700 to \$2,400 per month, any development of resistance will result in the use of additional and more expensive antiretrovirals, resulting in additional costs to the ADAP programs. At this time, Michigan ADAP has implemented multiple cost-reducing strategies to avoid a wait list.

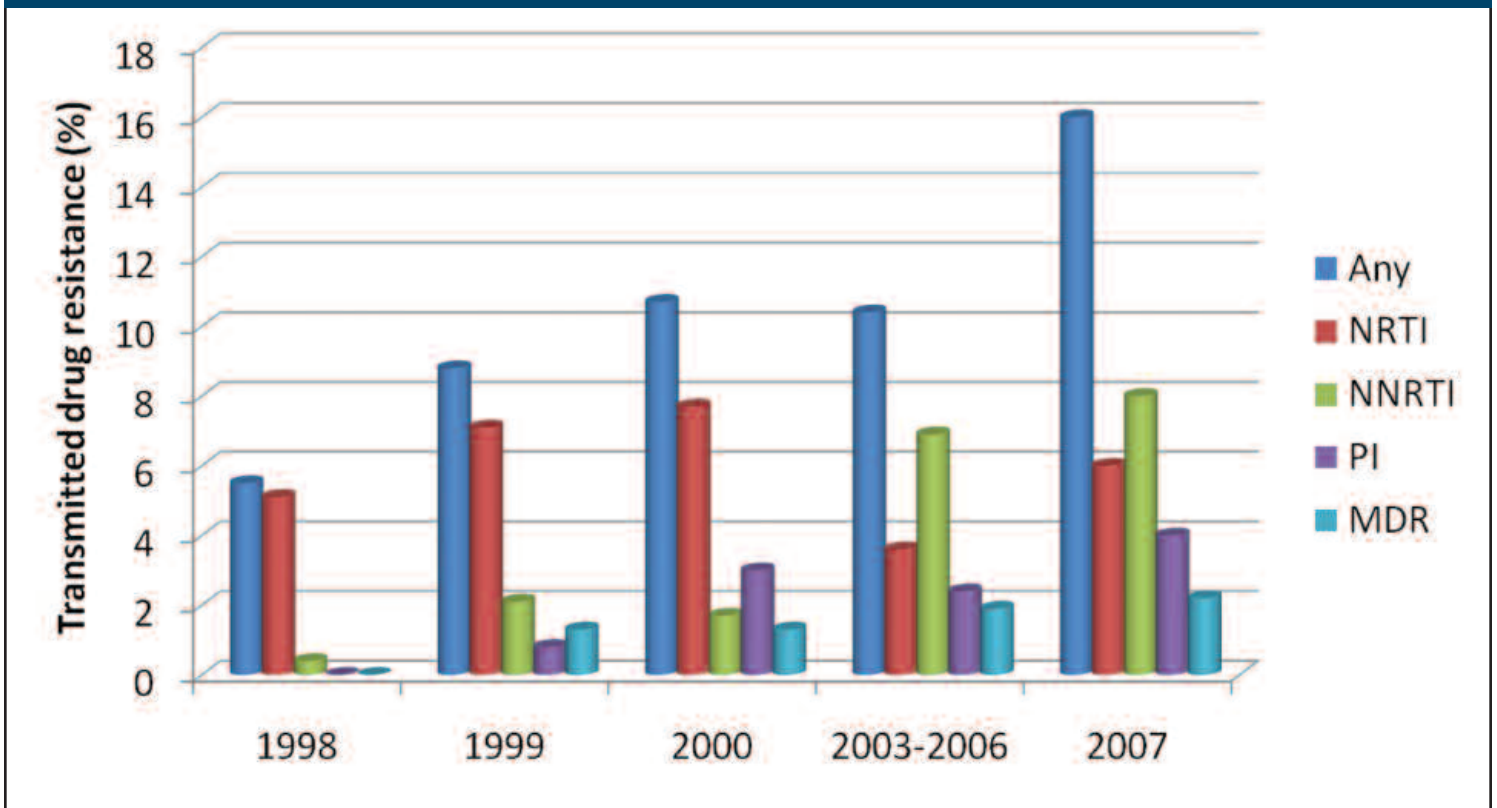
Role of the Pharmacist

Pharmacists play an important role in the care and management of patients receiving antiretrovirals. Pharmacists have varying roles in the HIV-related field: clinical and laboratory research, pharmacy benefits

programs, administrators with local, state and federal government agencies, consultants to state Ryan White HIV/AIDS Programs and ADAPs, clinical care teams and community pharmacies. They also serve as educators and trainers in the areas of HIV.⁵¹

There are tremendous opportunities for both clinic and community pharmacists in the care of a PLWHA. Responsibilities may include initiating therapy and providing medication counseling, management of side effects, interpretation of resistance testing, utilizing strategies and working with patients to improve adherence, reducing medication errors and advising on drug interactions. In the community setting, pharmacists play a large role as the “gatekeeper” of patient medication profiles and are relied upon to determine drug interactions between medications prescribed by physicians from different specialties who fail to communicate with each other.⁵¹

Figure 2: Patterns of Transmitted Drug Resistance



Bennei D, Zaidi I, Heneine W et al. Prevalence of Mutations Associated with Antiretroviral Drug Resistance among Recently Diagnosed Persons with HIV, 1998-2000. 9th Conference on Retrovirus and Opportunistic Infections, Feb. 24-28, 2002, Seattle, WA. Abstract 372. Wheeler W, Mahle K, Bodnar U et al. Antiretroviral Drug-Resistance Mutations and Subtypes in Drug-naïve Persons Newly Diagnosed with HIV-1 Infection, US, March 2003 to October 2006. 14th Conference on Retrovirus and Opportunistic Infections, February 25-28, 2007, Los Angeles, CA. Abstract 648. Kim D, Wheeler W, Ziebell R et al. Prevalence of Transmitted Antiretroviral Drug Resistance among Newly-diagnosed HIV-1-infected Persons, US 2007. 17th Conference on Retrovirus and Opportunistic Infections, Feb. 16-19, 2010, San Francisco, CA. Abstract 580.

With HIV therapy today, pharmacists are essential members of the health care team to help manage this chronic disease. In avoiding medication errors, pharmacists are encouraged to maintain a current knowledge of HIV therapy. By establishing and sustaining continuous communication with a patient's HIV providers, medication errors may be resolved quickly in preventing the development of resistance, and adherence barriers may be discussed and addressed with the entire health care team.

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References available upon request.

Important Information Regarding Pharmacy Technician Continuing Education Credit

Due to new guidelines established by Accreditation Council for Pharmacy Education (ACPE), certain changes must be made to the process by which MPA accredits continuing education for pharmacy technicians. MPA may choose to designate programs or home study articles as PTCE-accredited, rather than ACPE-accredited.

However, even though MPA may accredit a program for technicians, it is the technician's responsibility to determine whether the subject matter is acceptable to the Pharmacy Technician Certification Board (PTCB) for recertification. Programs designated by PTCB to be appropriate for technicians pertain to the following topics: medication distribution and inventory control systems, pharmacy administration and management calculations, programs specific to pharmacy technicians, interpersonal skills, organizational skills, pharmacy law and pharmacology/drug therapy. Programs relating to functions outside the scope of practice for pharmacy technicians will not be accepted by PTCB.

This is a knowledge-based activity.



Michigan Pharmacists Association is an approved provider of Pharmacy Technician Continuing Education (PTCE). PTCE Program #112-000-10-916-H02-T, 1.0 contact hour. Initial release date: 7/5/2010. Expiration date: 7/5/2013.



Michigan Pharmacists Association is accredited by the Accreditation Council for Pharmacy Education (ACPE) as a provider of continuing pharmacy education. ACPE Program #112-000-10-007-H02-P, 1.0 contact hour. Initial release date: 7/5/2010. Expiration date: 7/5/2013.

Continuing Education Self-Assessment Questions

- As patients living with HIV/AIDS may be on multiple medications to treat various disease states, it is the responsibility of the pharmacist to be vigilant in detecting potential drug interactions with antiretrovirals.
a. True b. False
- Patients may have a poor understanding of directions on the medication bottle; however, consequences are minimal.
a. True b. False
- Tom is picking up his prescription from your pharmacy. HAART: lamivudine/zidovudine 150 mg/300 mg tablets, 1 tablet twice daily. Lopinavir/ritonavir 200/50 mg tablets, 2 tablets twice daily. As you are counseling him on his HAART regimen, he asks you what times he should take his medication. As part of the education, you tell him.....
**a. whenever he likes throughout the day.
b. at 9 a.m. and 5 p.m. when he eats.
c. ideally, antiretrovirals should be taken every 12 hours.
d. he can take his meds all at the same time.**
- Two years later, Tom's regimen is changed to: abacavir/lamivudine 600/300 mg tablets, 1 tablet once daily, atazanavir 300 mg capsules, 1 capsule once daily, and ritonavir 100 mg capsules, 1 capsule once daily. You again counsel him on his new regimen and instruct him to take this regimen with food. He states to you "I never take my meds with food 'cause I have an iron-clad stomach and never get an upset stomach!" As part of the education, you tell him...
**a. he can continue with his routine practice.
b. the medications require food to help with absorption.
c. all medications need to be taken with food.**
- All antiretrovirals should be taken at the same time daily to prevent the development of viral resistance.
a. True b. False
- Hepatic metabolism of the CCR5 inhibitor, PIs and NNRTIs involve predominately which CYP450 enzyme system?
**a. CYP 2C19
b. CYP 2B6
c. CYP 3A4
d. None of the above**
- If there is no information for a drug interaction in a general database, no interaction exists.
a. True b. False
- Although adherence to HAART has correlated with better quality of life, it does not influence survival.
a. True b. False
- Suzie brings a prescription to you for a new HAART regimen. She states that she has developed resistance to her old regimen and is in need of new antiretrovirals. Which of the following may have influenced the development of resistance?
**a. Drug interactions
b. Taking her evening doses intermittently as she falls asleep on the couch
c. Not taking her HAART with food as indicated in the product insert
d. All of the above**
- Herbal supplementation is considered safe as they are derived from natural sources.
a. True b. False

The Basics in HIV: What Every Pharmacist Should Know, Part 2

July 2010 Enrollment Form
ACPE No. 112-000-10-007-H02-P
PTCE No. 112-000-10-916-H02-T

■ The passing score on each test is 70 percent. Upon successful completion of the test, MPA will mail you a continuing education statement of credit. A failed test may be retaken only once without additional cost within 30 days upon notification of a failing score. There are no refunds for failed tests.
■ The quiz may be taken anytime until July 5, 2013. Membership status will be certified using MPA records. Checks must accompany quiz — MPA will not bill you or correct the test unless the proper fee is enclosed.

■ This article offers 1.0 contact hour of continuing education. This lesson was developed specifically for pharmacists and certified pharmacy technicians.
■ Send the answer sheet with your check made payable to: **Michigan Pharmacists Association, 408 Kalamazoo Plaza, Lansing, MI 48933**. Please allow four weeks for processing.

Name _____ MPA ID# _____
Address _____ City _____ State _____ Zip _____
Signature _____

I enclose: Member Fee....\$7 Nonmember Fee....\$15
Please indicate if you are a Pharmacist Certified Pharmacy Technician
PCE EVALUATION — Circle the appropriate rating number for items 1 through 4.

- What is your evaluation of the article you read?
Poor 1 2 3 4 5 Excellent
- The author's coverage of the subject material was:
Incomplete 1 2 3 4 5 Complete
- How useful will the content of this article be in your practice?
Not at all 1 2 3 4 5 Very

- To what degree did the article meet the stated objectives?
- Identify situations leading to medication errors with antiretroviral prescriptions.
Not at all 1 2 3 4 5 Very
- Recognize how drug interactions and adherence impact the development of resistance.
Not at all 1 2 3 4 5 Very
- List the various sources of funding for persons living with HIV/AIDS.
Not at all 1 2 3 4 5 Very

Answer Sheet Instructions

Please write the letter of the correct answer to each question in the space provided.

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____ 8. _____ 9. _____ 10. _____

What other topics would you like to see presented in MPA's home study articles? _____