Table of Contents

Agenda

- Objective
- Drug assistance programs
- Data sources
- Overview of modules modified and added
- PrEP care continuum
- DAP enrollment
- DAP recertification
- DAP influence on outcomes
- DAP costs
- Use of `data.table` for input parameters

Objective

- The objective of WHAMP is to develop a simulation model of HIV in the state of Washington that can evaluate budget allocation questions related to drug assistance programs for HIV treatment (ART) and prevention (PrEP).
- Important features of these drug assistance programs include eligibility criteria, enrollment process, and benefits package (primarily paying client medical expenditures for covered services).
- Modified the `EpiModelHIV` package (branch `prep-race`) to incoporate the need of cost evaluation for the two programs.
- Features added to `EpiModelHIV` platform:
  - Costs paid by drug assistance program
  - Insurance/income characteristics of individuals
  - Drug assistance program enrollment and disenrollment processes
  - Influence of drug assistance program benefits on other EpiModel processes

Drug assistance programs

AIDS drug assistance program (ADAP)

- Originally conceived to pay for HIV treatment (ART) for people living with HIV who couldn't afford it
- Federally funded, but state-administered
- State determines eligibility, enrollment process, and benefits
- Following the passage of the affordable care act in 2010, more people had access to insurance that covered ART (Medicaid expansion; elimination of pre-existing condition clauses)
- Program goal remains the same (support access to ART), but benefits have changed

Washington State ADAP

- Benefits:
  - Provides assistance in acquiring insurance
  - Pays insurance premiums
  - Pays client-cost of HIV-related medications and healthcare services (deductibles, cost-sharing, co-pays)
  - Pays full cost of ART and HIV-related prescription medications for uninsured
- Eligibility depends on the income and insurance status of the individual
  - Income <400% Federal Povery Level
  - Currently uninsired, self-insured, employer-sponsored insurance
  - Not enrolled in Medicaid, Medicare, VA benefits (which cover ART)

Washington State PrEP drug assistance program (PrEP-DAP):

- Goal is to support access to PrEP for at-risk HIV-negative individuals
- Fully state funded; Washington state was the first to implement
- Gilead (pharmaceutical company) already provides patient drug co-pay assistance
  - Up to $7,200 per year (effective Sept. 1, 2018) for privately-insured
- PrEP-DAP Benefits:
  - Provides assistance in enrolling in Medicaid for those who are eligible
  - Provides assistance in enrolling in Gilead patient assistance programs
  - Pays client-cost of lab tests and medical visits needed for PrEP use (quarterly HIV/STI testing, kidney function, etc.)
  - Pays PrEP co-pays once Gilead benefit is exhausted
- Eligibility depends on the income and insurance of the individual
  - Not enrolled in Medicaid (which covers PrEP)
  - No income cut-off at this time

Data sources

The data sources to inform parameters are as follows:

1. Washington State Department of Health data for ADAP and PrEP-DAP
    - Population: All ADAP and PrEP-DAP clients
    - Data Collection Methods: Claims and administrative database, linked to some surveillance data (for viral load)
    - Availability: Client-level anonymized data is being provided to us by WADOH.
    - Parameters:
        - duration of enrollment
        - program size
        - costs, subdivided by HIV-related and other medical (ADAP), and PrEP drug costs and nondrug costs (PrEP)
2. ARTNET survey
    - Population: All Washington State MSM
    - Data Collection Methods: Online survey
    - Availability: In progress. Soon to be deployed?
    - Parameters:
        - income distribution (by age, race)
        - type of insurance distribution by income and race
        - PrEP awareness (by race)
        - current PrEP use (by race)
        - PrEP use patterns (by race)
        - ART usage (by race)
3. Washington PrEP DAP Client Survey
    - Population: All PrEP-DAP clients
    - Data Collection Methods: Mailed survey
    - Availability: Summary available. More available from WADOH, if needed?
    - Parameters:
        - Adherence on PrEP-DAP program
        - Behavior change for those on PrEP/in PDAP (?)
        - More?
4. Washington HIV Prevention Project (WAHPP)
    - Population: All Washington State MSM
    - Data Collection Methods: Online survey
    - Availability: Summary available. More available from WADOH, if needed?
    - Parameters
        - compare to ARTNET
5. Seattle Pride Survey
    - Population: MSM at Pride Parade
    - Data Collection Methods:
    - Availability: Summary available in Washington HIV-AIDS annual epidemiology report, pp. 46-50 link
    - Parameters?

Summary of modules modified and added

- To add the CEA functionality, we added the following groups of factors/features to the `EpiModelHIV` package.
  - Individual attributes
  - Income/insurance influences the original process
  - DAP enrollment
  - DAP recertification
  - DAP influences outcomes
  - Costs

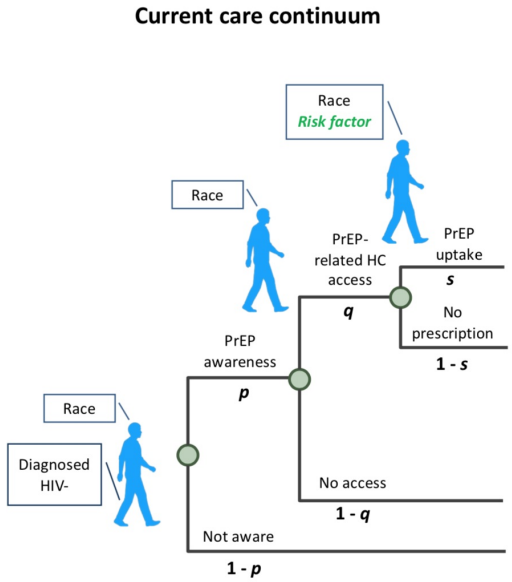
Color code:

1. Module added
2. Module modified
3. Factors/features to be added

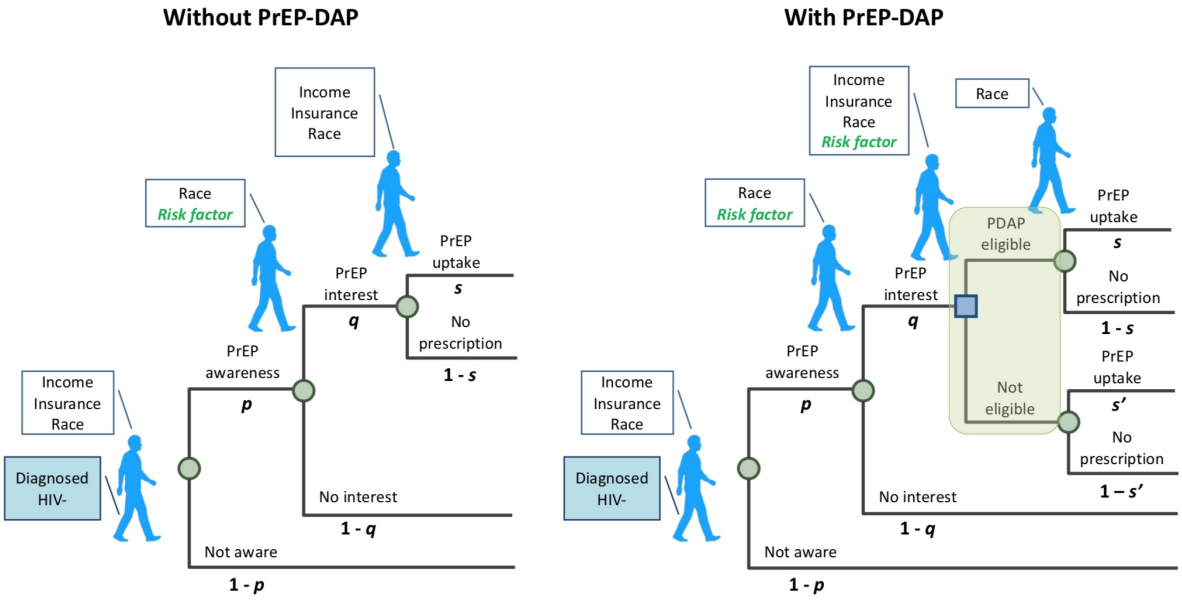
Factors/features	Modification/addition	Files changed/added
Individual attributes		
Annual income	Continuous and categorical income	param.R mod.initialize.R mod.births.R mod.insure_income.R
Insurance	5 levels: Uninsured, Self-pay bronze, Self-pay silver+, employer, government	params.R mod.initialize.R mod.births.R mod.insure_income.R
Region		
Interaction between age and the factors above		
Income/insurance influences process		
Test/trest trajectory	Test/treat trajectory interacts with insurance type	mod.initialize.R mod.births.R
PrEP awareness	Depends on both race and income	mod.prep.R
PrEP access	Depends on race, income, and insurance	mod.prep.R
DAP enrollment		
ADAP enrollment at diagnosis	Enrollemnt triggered at diagnosis. Depends on income and insurance type.	mod.adap.R
ADAP enrollment at other times	Background probability of filing application	mod.adap.R
PDAP enrollment	Depends on insurance type	mod.prep.R
DAP recertification		
ADAP recertification and discontinuation	Recertify at every 6 months. Potential for change in eligibility due to income and insurance changes.	mod.adap.R
PDAP recertification and discontinuation	Recertify every year. Depends on negative test in 90 days, race, risk factors.	mod.prep.R

DAP influences outcomes		
Test/treat trajectory	ADAP causes individuals to change from trajectory 2 to 3 or 4	mod.adap.R
ART initiation	ADAP enrollees have higher probability to start ART	mod.tx.R
ART discontinuation/ reinitiation	ADAP enrollees have lower probability to stop ART. ADAP enrollees have higher probability to reinitiate ART. There might be other factors influencing ADAP discontinuation: on treatment, income, and insurance, etc.	mod.tx.R
PrEP initiation	Depends on risk factors and PDAP attribute	mod.prep.R
Costs		
ADAP client costs	Premium ART treatment STI testing/treatment costs other healthcare costs	mod.cost.R
PDAP client costs	Gilead benefit HIV testing costs STI testing/treatment cost Other healthcare costs	mod.cost.R
ADAP assessment costs		
PDAP assessment costs		

PrEP care continuum



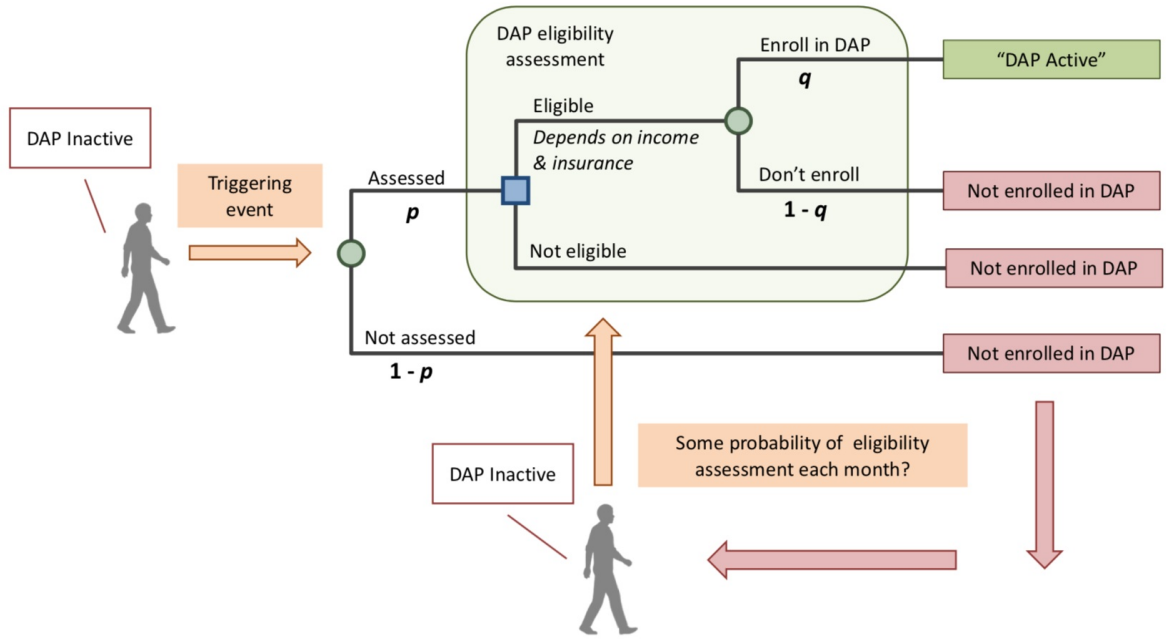
WHAMP PrEP care continuum



- PrEP awareness and uptake could depend on income, insurance, and risk factors.
- The existing code doesn't currently take PrEP interest into consideration.
- Do people who take PrEP ~= PDAP enrollees?
- How to incorporate PrEP interest and PrEP-DAP eligibility into the current care continuum structure?

Back

DAP enrollment



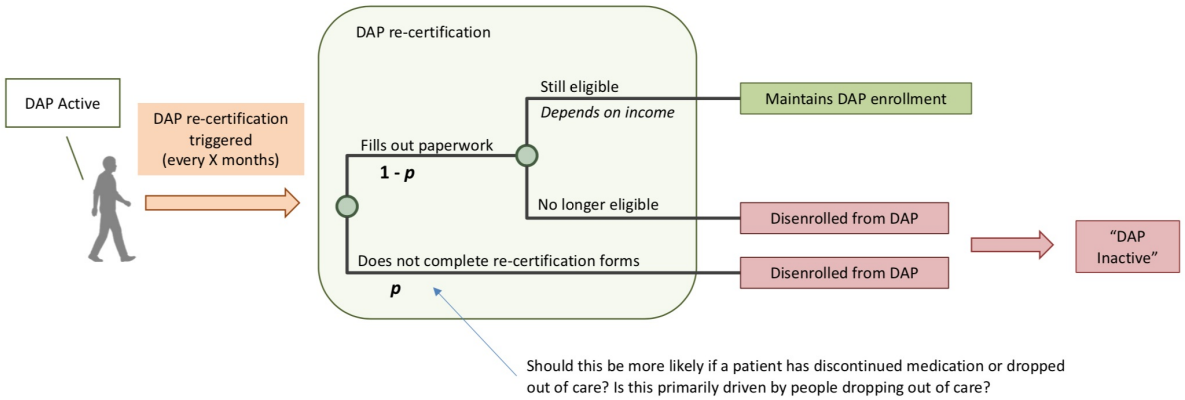
Eligibility criteria:

Program	Dignosis	Income	Insurance	Prescription	Risk factors
ADAP	Proof of HIV+	138%-400% of FPL	1. Uninsured: find insurance for them 2. Insured: exclude medicaid	Doesn't seem required	NA
PDAP	Tested HIV- within 14 days	>138% FPL for family of 1	Can be uninsured or insured but *cannot* receive medicaid	The providers are required to certify the prescription	1. STI+ in the last 12 months. 2. Unprotected sex outside of mutually monogamous relationship. 3. HIV+ partner is on ART but not virally suppressed.

- Questions to DOH:
  - Do ADAP enrollees have to initiate ART to be eligible to ADAP?
  - Do PrEP-DAP enrollees have to initiate PrEP to be eligible to PrEP-DAP?
  - Are the risk factors considered as elibility criteria in PrEP-DAP application?

Back

DAP recertification



Recertification criteria:

Program	Frequency of recertifications	Diagonisis
ADAP	Every 6 months	NA
PDAP	Every year	HIV- test in the last 90 days

Back

DAP status influences outcomes

- Individuals have a DAP attribute, assigned to be "DAP active" for upon successful DAP enrollment
- ADAP:
  - Individuals who were originally assigned to be in trajectory 2 (test, never treated) could change to trajectory 3 (treated, partial suppression) or 4 (treated, full suppression) if ADAP active
  - ADAP active have higher probability of (re)initiating ART
  - ADAP active have lower probability of discontinuing ART
- PrEP-DAP:
  - PrEP-DAP active are more likely to initiate PrEP
  - Question: would PrEP-DAP clients behave differently than individuals who are on PrEP but not enrolled in PrEP-DAP?
  - Possible behaviors that may be influenced by PrEP-DAP enrollment:
    - discontinuation
    - adherence to PrEP
    - frequency of HIV/STI testing

Back

DAP costs

- ADAP costs
  - Client costs
    - insurance premium
    - ART out of pocket costs coverage
    - healthcare out of pocket cost coverage (select services)
  - Assessment cost
- PrEP-DAP costs
  - Client costs
    - Gilead benefits
    - Medical and lab visits costs
    - STI treatment costs
    - other relevante healthcare costs (selective services)
  - Assessment cost

Back

Use of `data.table` for managing parameters

- Model parameters often depend on multiple attributes such as race, income, insurance, etc.
- A complex model could lead to inscreasing interdependency among attributes, resulting in two issues:
  - parameter storage
  - parameter accessing
- We used `data.table` (`library(data.table)`) to reduce the burden of the parameter accessing issue.
- A `data.table` looks like `data.frame` with enhanced features. Features that related to parameter accessing are
  - By defining the key(s) in `data.table` , it can look up values corresponding to the key attributes in vector form.
  - The speed of data accessing is faster than `data.frame` and than `list` (if you setup the keys!).
  - It can do some calculation and sampling.
- Comparison between `data.table` , `data.frame` , `list` , and `matrix` .
  - `data.frame` and `list` : require to access the value for person *i* to person *n* one by one.
  - `matrix` in `R` could be very fast but it might not be readable.

Example 1 (a simple example):

- We arranged the input parameter `p.adap.traj2to34` in `data.table` (input parameters in `param_msm` function).
  - This parameter could be different by race.
- In the formation of `data.table` , we set up the race as the key of this table.

```
> p.adap.traj2to34 = data.table(race = c("B", "W"), prop = c(0.5, 0.7), key = c("race"))
> print(p.adap.traj2to34)
   race prop
1:    B  0.5
2:    W  0.7
```

- For 10 individuals, we can look up the corresponding `prop` value based on the race of each individual in the simulation.

```
> race.vec = sample(c("B", "W"), size = 10, replace = T)
> print(race.vec)
[1] "B" "B" "W" "B" "W" "W" "W" "B" "B" "B"

> print(p.adap.traj2to34[race.vec])
    race prop
 1:    B  0.5
 2:    B  0.5
 3:    W  0.7
 4:    B  0.5
 5:    W  0.7
 6:    W  0.7
 7:    W  0.7
 8:    B  0.5
 9:    B  0.5
10:    B  0.5
```

Example 2 (more complicated structure):

- A more complicated example: Suppose that the distribution of insurance type depends on income and race.
- In the current code, we managed the input parameter using list and transform the list to `data.table` in the `param_msm` function.

- A `data.table` allows multiple keys.

```
dist.insure.type.raw = list(B = matrix(c(0.3, 0, 0, 0, 0.7,
                                         0.2, 0.6, 0.1, 0, 0.1,
                                         0, 0.35, 0.39, 0.25, 0.01,
                                         0, 0.10, 0.40, 0.49, 0.01,
                                         0, 0.10, 0.40, 0.49, 0.01),
                                         dimnames = list(c(1:5), c("uninsured", "self bronze", "self non-bronze", "
employer", "government")),
                                         nrow = 5, byrow = T),
                            W = matrix(c(0.3, 0, 0, 0, 0.7,
                                         0.2, 0.6, 0.1, 0, 0.1,
                                         0, 0.35, 0.39, 0.25, 0.01,
                                         0, 0.10, 0.40, 0.49, 0.01,
                                         0, 0.10, 0.40, 0.49, 0.01),
                                         dimnames = list(c(1:5), c("uninsured", "self bronze", "self non-bronze", "
employer", "government")),
                                         nrow = 5, byrow = T))

dist.insure.type = data.table(race = rep(c("B", "W"), each = 5),
                              income.cate = rep(c(1:5), 2),
                              do.call(rbind, dist.insure.type.raw),
                              key = c("race", "income.cate"))
```

- We can look up values for each individual based on the information of race and income (categorical income).

```
> ix.race = sample(c("B", "W"), replace = T, 12)
> print(ix.race)
 [1] "W" "B" "W" "W" "B" "B" "B" "B" "W" "B" "W" "B"
> ix.income = sample(c(1:5), replace = T, 12)
> print(ix.income)
 [1] 5 3 3 5 1 4 4 4 1 4 3 3
> dist.insure.type[.(ix.race, ix.income)]
    race income.cate uninsured self bronze self non-bronze employer government
 1:    W           5       0.0        0.10            0.40     0.49       0.01
 2:    B           3       0.0        0.35            0.39     0.25       0.01
 3:    W           3       0.0        0.35            0.39     0.25       0.01
 4:    W           5       0.0        0.10            0.40     0.49       0.01
 5:    B           1       0.3        0.00            0.00     0.00       0.70
 6:    B           4       0.0        0.10            0.40     0.49       0.01
 7:    B           4       0.0        0.10            0.40     0.49       0.01
 8:    B           4       0.0        0.10            0.40     0.49       0.01
 9:    W           1       0.3        0.00            0.00     0.00       0.70
10:    B           4       0.0        0.10            0.40     0.49       0.01
11:    W           3       0.0        0.35            0.39     0.25       0.01
12:    B           3       0.0        0.35            0.39     0.25       0.01
> colsel = c("uninsured", "self bronze", "self non-bronze", "employer", "government")
> dist.insure.type[.(ix.race, ix.income), ..colsel]
>     uninsured self bronze self non-bronze employer government
 1:         0.0        0.10            0.40     0.49       0.01
 2:         0.0        0.35            0.39     0.25       0.01
 3:         0.0        0.35            0.39     0.25       0.01
 4:         0.0        0.10            0.40     0.49       0.01
 5:         0.3        0.00            0.00     0.00       0.70
 6:         0.0        0.10            0.40     0.49       0.01
 7:         0.0        0.10            0.40     0.49       0.01
 8:         0.0        0.10            0.40     0.49       0.01
 9:         0.3        0.00            0.00     0.00       0.70
10:         0.0        0.10            0.40     0.49       0.01
11:         0.0        0.35            0.39     0.25       0.01
12:         0.0        0.35            0.39     0.25       0.01
```

Example 3 (with sampling):

- Random sample for each individual based on their key attributes.

```
> prob.DT = data.table(race = rep(c("B", "W"), each = 2),
+                      income.cate = rep(c(1:2), 2),
+                        prop = rep(c(0.2, 0.5), 2),
+                        key = c("race", "income.cate"))
> print(prob.DT)
   race income.cate prop
1:    B           1  0.2
2:    B           2  0.5
3:    W           1  0.2
4:    W           2  0.5

> ix.race = sample(c("B", "W"), 20, replace = T)
> print(ix.race)
[1] "W" "B" "B" "B" "B" "B" "W" "B" "B" "W" "B" "B" "W" "B" "W" "B" "B" "W" "B" "B"

> ix.income.cate = sample(c(1:2), 20, replace = T)
> print(ix.income.cate)
[1] 1 1 2 2 2 1 2 1 2 2 2 2 2 2 2 2 1 1 2

> prob.DT[.(ix.race, ix.income.cate), rbinom(.N, 1, prop)]
[1] 0 0 1 1 0 0 1 0 1 0 1 0 0 0 0 0 1 1 0 1
```

- PrEP DAP application form
- ADAP application form