Exploring the Incidence-TID-Undx Relationship

Jeanette Birnbaum

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1 Overview

This is an attempt to use a simple constant-incidence simulation to explore the impact of a change in TID on undiagnosed estimates.

2 Two different incidences with the same TID

```
# TID pdfs: B has a 0.1 shift into year 1, whereas C has a 0.1 shift into year 2
cbind(tidA, tidB, tidC)

##      tidA tidB tidC
## [1,]  0.5  0.6  0.5
## [2,]  0.3  0.3  0.4
## [3,]  0.2  0.1  0.1

# Higher incidence
lapply(inc1, "[[", 6)

## [[1]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      30   48   60   60   60
## Diagnosed Prevalence    30   78  138  198  258
## True Prevalence         60  120  180  240  300
## Undiagnoses per Year    30   42   42   42   42
##
## [[2]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      36   54   60   60   60
## Diagnosed Prevalence    36   90  150  210  270
## True Prevalence         60  120  180  240  300
## Undiagnoses per Year    24   30   30   30   30
##
## [[3]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      30   54   60   60   60
## Diagnosed Prevalence    30   84  144  204  264
## True Prevalence         60  120  180  240  300
## Undiagnoses per Year    30   36   36   36   36

# Lower incidence
lapply(inc2, "[[", 6)

## [[1]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      20   32   40   40   40
## Diagnosed Prevalence    20   52   92  132  172
## True Prevalence         40   80  120  160  200
## Undiagnoses per Year    20   28   28   28   28
##
## [[2]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      24   36   40   40   40
## Diagnosed Prevalence    24   60  100  140  180
## True Prevalence         40   80  120  160  200
```

```
## Undiagnoses per Year   16   20   20   20   20
##
## [[3]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      20   36   40   40   40
## Diagnosed Prevalence    20   56   96  136  176
## True Prevalence         40   80  120  160  200
## Undiagnoses per Year    20   24   24   24   24
```

When incidence is higher, absolute shifts in undiagnosed cases due to TID changes will be greater than when incidence is lower: 42 to 30 or 36, versus 28 to 20 or 24. Proportional changes are the same: $30/42 = 20/28$, and $36/42 = 24/28$.

TIDs B and C have the same amount of probability shifted away from year 3. When that 0.1 is shifted into year 1 instead of year 2, the drop in undiagnosed counts doubles. This demonstrates the time-significance of where probability is shifted. Let's look at the PDFs of the CD4 Case. Maybe the CDFs are not the best transformation to investigate. Or, maybe this will not explain the results, either.

3 MSM versus non-MSM pdfs

Table 1: Base Case versus CD4 Case PDFs

Pop	Time	bc_pdf	cd4case_pdf	diff	ratio
MSM	0.000	0.314	0.317	0.002	0.992
	0.250	0.160	0.162	0.002	0.985
	0.500	0.091	0.093	0.002	0.974
	1.000	0.043	0.045	0.002	0.946
	5.000	0.005	0.005	-0.000	1.078
	18.000	0.000	0.000	0.000	
non-MSM	0.000	0.120	0.125	0.005	0.964
	0.250	0.081	0.085	0.005	0.947
	0.500	0.063	0.068	0.005	0.933
	1.000	0.041	0.046	0.005	0.901
	5.000	0.012	0.011	-0.001	1.059
	18.000	0.000	0.000	0.000	

So this is not the story, since the pdfs show greater changes in non-MSM than in the MSM.

4 Shifts in two different types of TIDs

The idea is to explore how shifts in a TID with shorter times to diagnosis compare with shifts in a flatter TID, one with longer times to diagnosis.

```
# TIDs
tids

##      tidA1 tidA2 tidB1 tidB2
## [1,]   0.5   0.6   0.3 0.330
## [2,]   0.3   0.2   0.3 0.331
## [3,]   0.1   0.1   0.2 0.210
## [4,]   0.1   0.1   0.2 0.129

# The curve stats
Sx <- apply(tids, 2, function(x) {
    1 - cumsum(x)
})
(means <- apply(Sx, 2, TIDstats, intLength = 1)[1, ])

## tidA1 tidA2 tidB1 tidB2
## 0.800 0.700 1.300 1.138

# Ratios and differences: TID A2 vs A1
means["tidA2"]/means["tidA1"]
```

```
## tidA2
## 0.875

means["tidA2"] - means["tidA1"]

## tidA2
##  -0.1

# Ratios and differences: TID B2 vs B1
means["tidB2"]/means["tidB1"]

##     tidB2
## 0.8753846

means["tidB2"] - means["tidB1"]

##  tidB2
## -0.162

# The undiagnosed counts for each TID when incidence is constant at 40

# TIDs A1 and A2
lapply(incA, "[[", 6)

## [[1]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      20   32   36   40   40
## Diagnosed Prevalence    20   52   88  128  168
## True Prevalence         40   80  120  160  200
## Undiagnoses per Year    20   28   32   32   32
##
## [[2]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      24   32   36   40   40
## Diagnosed Prevalence    24   56   92  132  172
## True Prevalence         40   80  120  160  200
## Undiagnoses per Year    16   24   28   28   28

# TIDs B1 and B2
lapply(incB, "[[", 6)

## [[1]]
##                       2011 2012 2013 2014 2015
## Diagnoses per Year      12   24   32   40   40
## Diagnosed Prevalence    12   36   68  108  148
## True Prevalence         40   80  120  160  200
## Undiagnoses per Year    28   44   52   52   52
##
## [[2]]
##                       2011  2012   2013   2014   2015
## Diagnoses per Year    13.2 26.44  34.84  40.00  40.00
## Diagnosed Prevalence  13.2 39.64  74.48 114.48 154.48
## True Prevalence       40.0 80.00 120.00 160.00 200.00
## Undiagnoses per Year  26.8 40.36  45.52  45.52  45.52

# Scenario A: shorter times to diagnosis
28/32

## [1] 0.875

28 - 32

## [1] -4

# Scenario B: flatter TID
45.52/52

## [1] 0.8753846

45.52 - 52

## [1] -6.48
```

5 Shifts in two different types of TIDs, declining incidence