Adding Stage of Infection to HIV Back-Calculation in WA State, 2005-2014

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1 Overview

This report contains the initial results comparing the standard testing history model results for WA State undiagnosed estimates to an extended model incorporating stage of infection data. This version of the report focuses on the impact of BED results rather than dual diagnosis, in order to understand why the BED data have only a minor impact.

2 Understanding the Data

2.1 Construction of analytic sample

Data from the advanced HIV/AIDS reporting system (eHARS) and the CDC treatment and testing history questionnaire (HIS) provided records for 26,134 HIV cases in WA state.[1]

Figure 1 diagrams the construction of the analytic sample. We first restricted to cases diagnosed in WA state in the years 2005-2014. We further excluded cases diagnosed at age 16 or younger if their date of last negative test was missing, because the assumptions we use when date of last negative test is missing are not applicable to this age group.

The final sample includes 5,176 cases. In the 2014 report there were 4744 cases in the final sample across diagnosis years 2005-2013. Of the additional 447 diagnoses reported in 2014 eligible for this anaylsis, 432 met all our inclusion criteria.

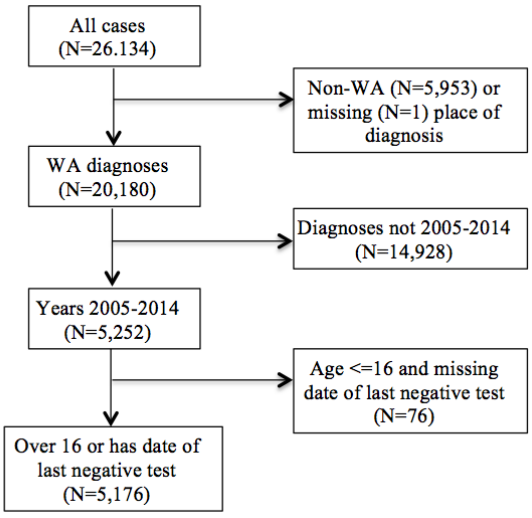

Figure 1: Construction of analytic sample

[1] Provided by Jason Carr, Washington State Department of Health, June 2015

2.2 Frequencies of and trends in BED and dual diagnosis

Table 1 shows the sample breakdown by BED status and dual diagnosis (DD) status over 2005-2014, where a dual diagnosis is defined as AIDS within 1 year of the HIV diagnosis. From the "Total" column we see that the BED+ population is 17% of the sample. In 2014, the BED+ drop to 7% of the sample (Table 2).

Within the BED+, 11% are DD+ (Table 1). We are assuming these are true recent infections of individuals who have a fast disease progression, although this is a matter for further research. The current assumption maximizes the impact of the BED information.

Of those with a missing BED result, 43% have a dual diagnosis, which is substantially higher than the percentages among those with a BED+ or BED- result (Table 1). This suggests those with a BED result do not well-represent those with missing BED.

1. Who gets a BED test, and why? 2. What is the reporting delay on BED results? On AIDS diagnoses?

Table 1: Cross-tabulation of BED and dual diagnoses, 2005-2014. Row percents show the percent of dual diagnoses (DD) within each BED group or the total sample (last row)

	DD+		DD-		Total	
	N	Row %	N	Row %	N	Col %
BED +	101	11	779	89	880	17
BED -	382	27	1029	73	1411	27
BED Miss	1238	43	1647	57	2885	56
Total	1721	33	3455	67	5176	100

Table 2: Cross-tabulation of BED and dual diagnoses, 2014 only

	DD+		DD-		Total	
	N	Row %	N	Row %	N	Col %
BED +	2	6	29	94	31	7
BED -	2	6	32	94	34	8
BED Miss	119	32	257	68	376	85
Total	123	28	318	72	441	100

2.3 Time trends

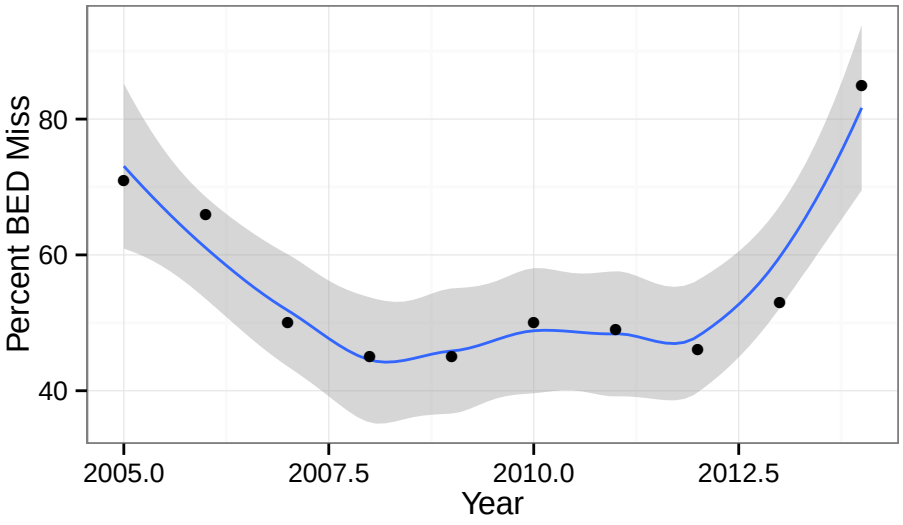

Figure 2: Percent of cases who have a missing BED result, by year

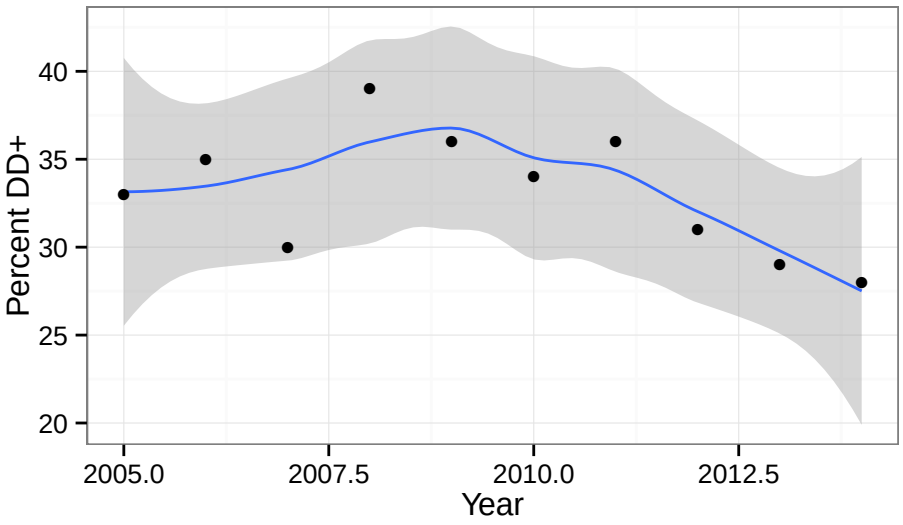

Figure 3: Percent of cases who have a dual diagnoses, by year

2.4 Relationship between BED and testing histories

Tables 3 and 4 show the breakdown of testing histories within BED groups, overall and for MSM vs non-MSM transmission groups, respectively. Individuals who have a BED+ result are much more likely to also have reported a LNT (71%) than those with a BED- result (50%) or those with missing BED (37%).

Table 3: Testing history responses by BED status. Column % sums to 100 across all rows. Availability of testing history data within each subgroup level is shown as row percents

				Ever Had a Negative Test		
Characteristic	Subgroup	N	Column %	% Yes	% No	% Missing
BED Result	BED +	880	17	71	7	21
	BED -	1411	27	50	16	34
	BED Miss	2885	56	37	12	52
Total		5176	100	46	12	42

Table 4: Testing history responses by BED status, separately for MSM and non-MSM. Column % sums to 100 across all rows. Availability of testing history data within each subgroup level is shown as row percents

				Ever Had a Negative Test		
Transmission Mode	BED Result	N	Column %	% Yes	% No	% Missing
MSM	BED +	685	13	80	5	16
	BED -	872	17	63	12	24
	BED Miss	1846	36	46	9	45
non-MSM	BED +	195	4	42	17	41
	BED -	539	10	29	21	50
	BED Miss	1039	20	20	16	64
Total		5176	100	46	12	42

We see this correlation in the MSM/non-MSM subgroups as well (Table 4). It is not ideal, since having a BED+ result would be most useful for those who reported never having an LNT. Among non-MSM, however, there are relatively more BED+ with no LNT than among MSM, so the BED+ information will be more influential for them. The BED+ non-MSM only comprise 4% of the population, however, so the impact of this group on the total estimates will be small.

3 Stage of infection impact on infection window

3.1 Numbers of cases affected by a BED+ result

There are two types of BED+ cases whose BED+ result influences our model: those who report having no LNT, and those who report a LNT that is greater than the BED window (162 days). In both cases, we shorten the infection window to the BED window.

Table 5 summarizes the distribution of cases by type of change. Those "Changed by being BED+" who have a LNT are not only BED+ but also have a reported infection window that is greater than the BED window of 162 days.

Table 5: For the 3013 cases with non-missing testing history, N and row percents of each LNT/no LNT group not impacted by stage of infection data (No Change) or impacted by being BED+ and having an infection window greater than 162 days (Changed by BED+)

	No Change		Changed by BED+		
	N	Row %	N	Row %	Total
LNT	1981.0	82.7	413.0	17.3	2394.0
no LNT	554.0	89.5	65.0	10.5	619.0
Total	2535.0	84.1	478.0	15.9	3013.0

3.2 Degree of impact of the BED+ result

We saw above that 17.3% of cases with an LNT will be affected by the BED+ result. When we look at the infection windows of the BED+ before and after modification, we see that the long tail of infection windows is reigned in (Table 6). However, the 1st quartile remains unchanged and the median drops only slightly when the BED+ information is used.

Table 6: Among the BED+, summary of infection windows pre- and post- modification by BED+, in years

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
Original BED+ infection windows	0.003	0.366	0.748	2.514	1.970	17.980	189.000
After modifying windows for BED+	0.003	0.366	0.444	0.384	0.444	0.444	189.000

Table 7 shows how this translates into the various cases for the TID estimates.

Table 7: Among the BED+, the fraction remaining undiagnosed at quarter-year time steps, using the different cases. Time indicates the left/lower bound of the time interval

Time	Original Base Case	Modified Base Case	Original Upper Bound	Modified Upper Bound
0.000	0.579	0.345	0.861	0.861
0.250	0.386	0.000	0.641	0.000
0.500	0.290	0.000	0.499	0.000
1.000	0.201	0.000	0.337	0.000

4 Four stage-of-infection groups

We originally wanted to stratify our estimation by all six subgroups defined by the three BED categories and two dual diagnosis categories. However, due to small samples of BED+/- DD+ (Table 3), we aggregated into four subgroups: BED+, BED-, BED missing DD+ (BEDmDD+), and BED missing DD- (BEDmDD-).

5 Undiagnosed Results

5.1 Time from infection to diagnosis (TID)

Figure 4 shows the original and modified base case TIDs for each of the four stage-subgroups.

5.2 Unstratified, Without-Stage Results

The estimated incidence and undiagnosed counts for each scenario are shown as quarterly counts in Figure 6 and summarized over all quarters in Table 8. These results are not stratified by any group, although we do have a version of the total results that reflects stratification by MSM and non-MSM.

Table 8: Observed diagnoses and estimated quarterly incidence and undiagnosed counts over 2005-2014 in WA state

Diagnoses/Case	Estimate	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
# Diagnosed	Diagnoses	91	120	129	129	140	163
Base Case	Incidence	108	115	126	124	134	138
Base Case	Undiagnosed Cases	1236	1303	1401	1371	1435	1461
Upper Bound	Incidence	105	109	121	120	130	135
Upper Bound	Undiagnosed Cases	2473	2575	2739	2704	2818	2870

Table 9: Estimated true prevalence and the undiagnosed fraction in WA state, limited to just 2014

Year	Diagnoses/Case	Estimate	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
2014.0	PLWHA	PLWHA				12691.0		
2014.0	Base Case	Undiagnosed Cases	1236.0	1243.0	1253.0	1251.0	1261.0	1262.0
2014.0	Base Case	True Prevalence	13927.0	13934.0	13944.0	13942.0	13952.0	13953.0
2014.0	Base Case	Undiagnosed Fraction (%)	8.9	8.9	9.0	9.0	9.0	9.0
2014.0	Upper Bound	Undiagnosed Cases	2473.0	2480.0	2494.0	2492.0	2507.0	2509.0
2014.0	Upper Bound	True Prevalence	15164.0	15171.0	15185.0	15183.0	15198.0	15200.0
2014.0	Upper Bound	Undiagnosed Fraction (%)	16.3	16.3	16.4	16.4	16.5	16.5

5.3 Stratified, Without- and With-Stage Results

When we run the model allowing stage (so far, just BED) to impact the TID, we also stratify by stage subgroups in order for the missing testing histories to be missing conditional on stage subgroup.

Quarterly incidence and undiagnosed counts are plotted in Figure 7. The summary results over 2005-2015 and for 2014 alone are given in Table 10. The mean without- and with-stage undiagnosed estimates for those two time periods are compared in Table 11. Table 12 shows the 2014 undiagnosed fraction results as well.

Regarding the impact on uncertainty, from Table 11 we can additionally calculate that the undiagnosed range in 2014 was 1,277-2,502 and adding stage decreased that to 1,195-2,344, which amounts to a difference of 76 cases. From Table 12 that amounts to a decrease from 7.2% to 6.9% for the range of the mean undiagnosed fraction.

Table 10: Observed diagnoses and estimated quarterly incidence and undiagnosed counts over 2005-2014 and just 2014 in WA state, using stage-subgroup strata

Year	Case	Estimate	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
2005-2014	Base Case	Undiagnosed Cases	1269	1372	1433	1403	1443	1467
2005-2014	Base Case using Stage	Undiagnosed Cases	1188	1288	1405	1350	1413	1432
2005-2014	Upper Bound	Undiagnosed Cases	2487	2640	2844	2756	2871	2901
2005-2014	Upper Bound using Stage	Undiagnosed Cases	2328	2448	2678	2599	2743	2757
2014	Base Case	Undiagnosed Cases	1269	1274	1279	1277	1280	1282
2014	Base Case using Stage	Undiagnosed Cases	1188	1192	1196	1195	1198	1200
2014	Upper Bound	Undiagnosed Cases	2487	2498	2509	2502	2510	2511
2014	Upper Bound using Stage	Undiagnosed Cases	2328	2339	2349	2344	2352	2354

Table 11: Impact of using BED result to modify the TID on mean undiagnosed estimates

Year	Case	With Stage	Without Stage	Difference	Percent Change
2005-2014	Base Case	1350.0	1403.0	-53.0	-4.0
2005-2014	Upper Bound	2599.0	2756.0	-157.0	-6.0
2014	Base Case	1195.0	1277.0	-82.0	-6.0
2014	Upper Bound	2344.0	2502.0	-158.0	-6.0

Table 12: Estimated true prevalence and the undiagnosed fraction for 2014 in WA state, using stage-subgroup strata

Year	Diagnoses/Case	Estimate	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
2014.0	PLWHA	PLWHA				12691.0		
2014.0	Base Case	Undiagnosed Cases	1269.0	1274.0	1279.0	1277.0	1280.0	1282.0
2014.0	Base Case using Stage	Undiagnosed Cases	1188.0	1192.0	1196.0	1195.0	1198.0	1200.0
2014.0	Upper Bound	Undiagnosed Cases	2487.0	2498.0	2509.0	2502.0	2510.0	2511.0
2014.0	Upper Bound using Stage	Undiagnosed Cases	2328.0	2339.0	2349.0	2344.0	2352.0	2354.0
2014.0	Base Case	True Prevalence	13960.0	13965.0	13970.0	13968.0	13971.0	13973.0
2014.0	Base Case using Stage	True Prevalence	13879.0	13883.0	13887.0	13886.0	13889.0	13891.0
2014.0	Upper Bound	True Prevalence	15178.0	15189.0	15200.0	15193.0	15201.0	15202.0
2014.0	Upper Bound using Stage	True Prevalence	15019.0	15030.0	15040.0	15035.0	15043.0	15045.0
2014.0	Base Case	Undiagnosed Fraction (%)	9.1	9.1	9.2	9.1	9.2	9.2
2014.0	Base Case using Stage	Undiagnosed Fraction (%)	8.6	8.6	8.6	8.6	8.6	8.6
2014.0	Upper Bound	Undiagnosed Fraction (%)	16.4	16.4	16.5	16.5	16.5	16.5
2014.0	Upper Bound using Stage	Undiagnosed Fraction (%)	15.5	15.6	15.6	15.6	15.6	15.6

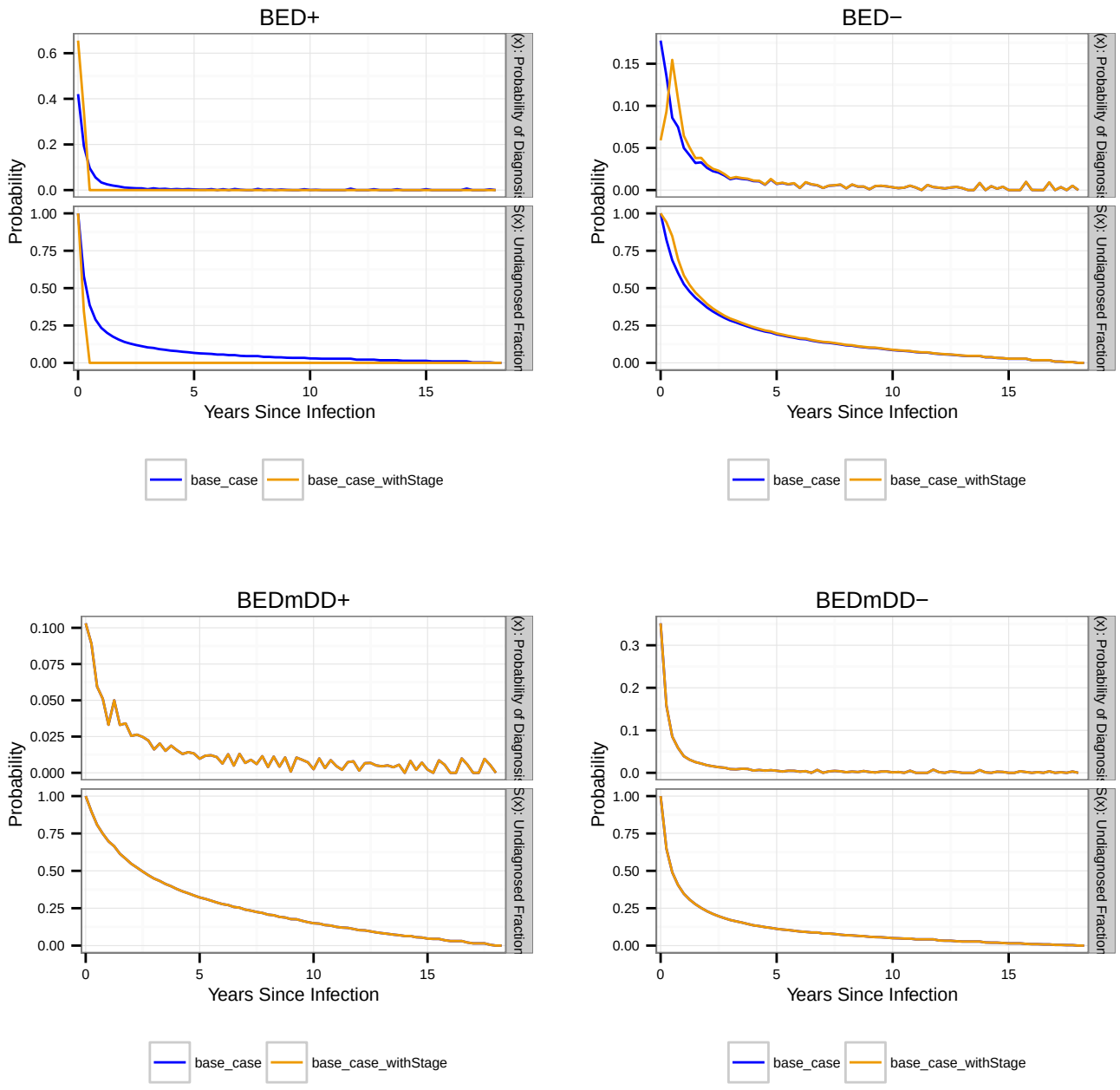

Figure 4: Time from infection to diagnosis (TID) for base case without and with stage, 4 groups

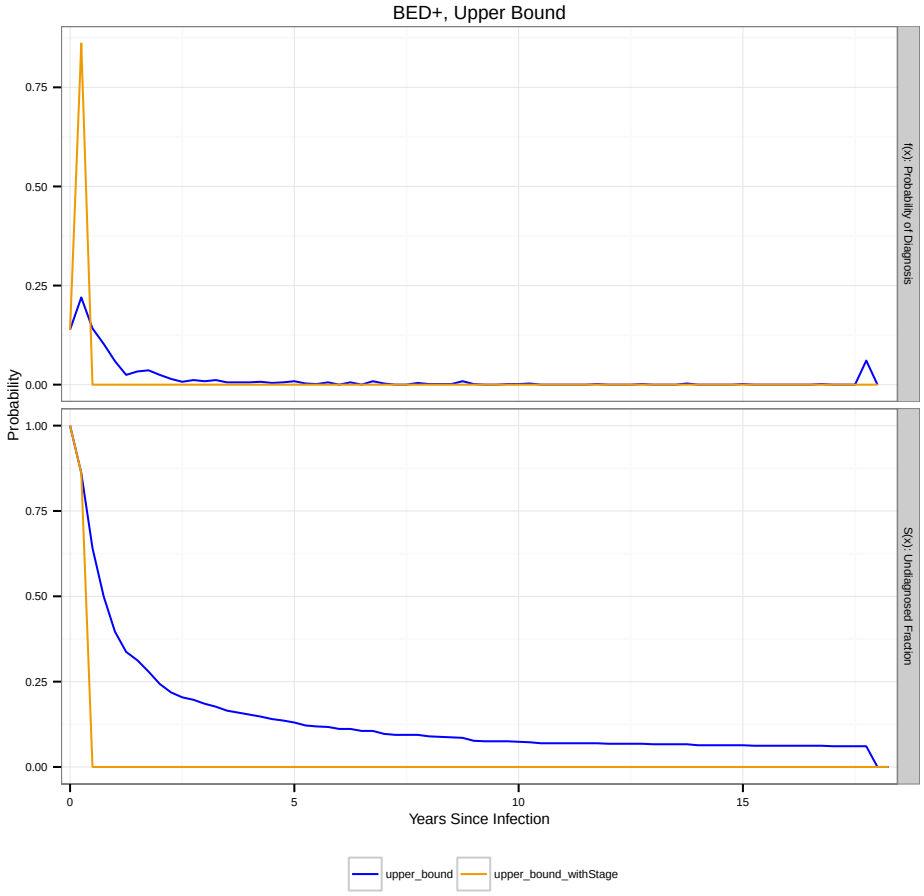

Figure 5: Time from infection to diagnosis (TID) for upper bound without and with stage, BED+

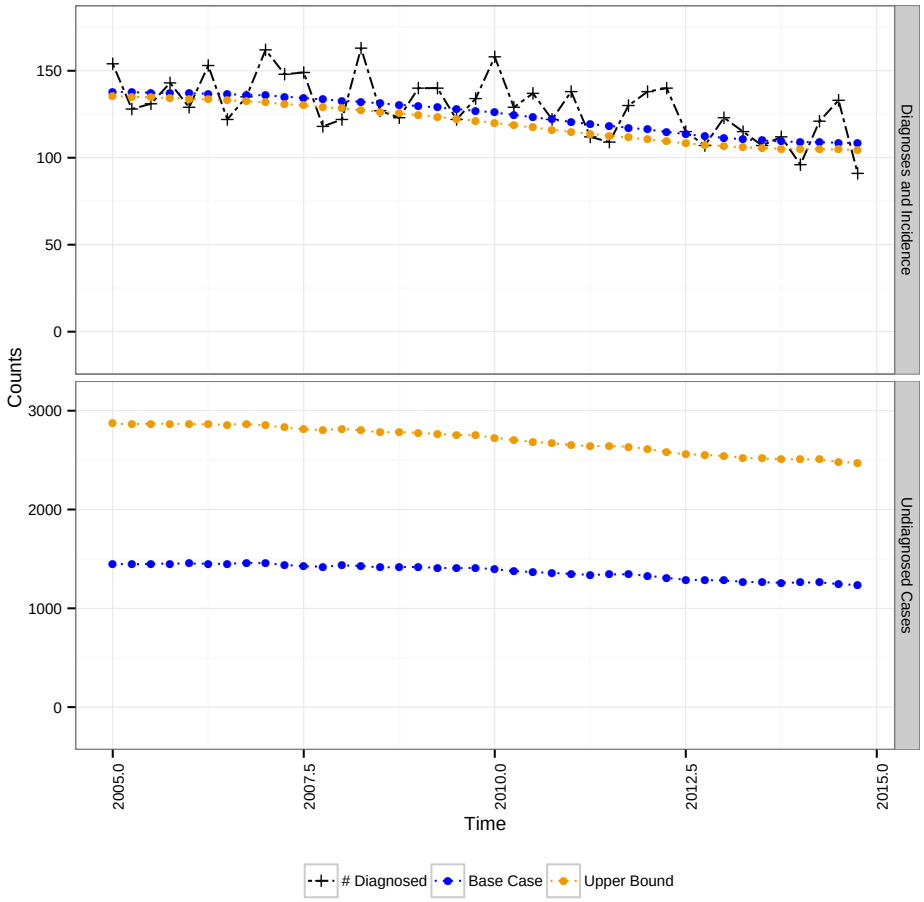

Figure 6: Observed diagnoses and estimated quarterly and undiagnosed counts over 2005-2014 in WA state

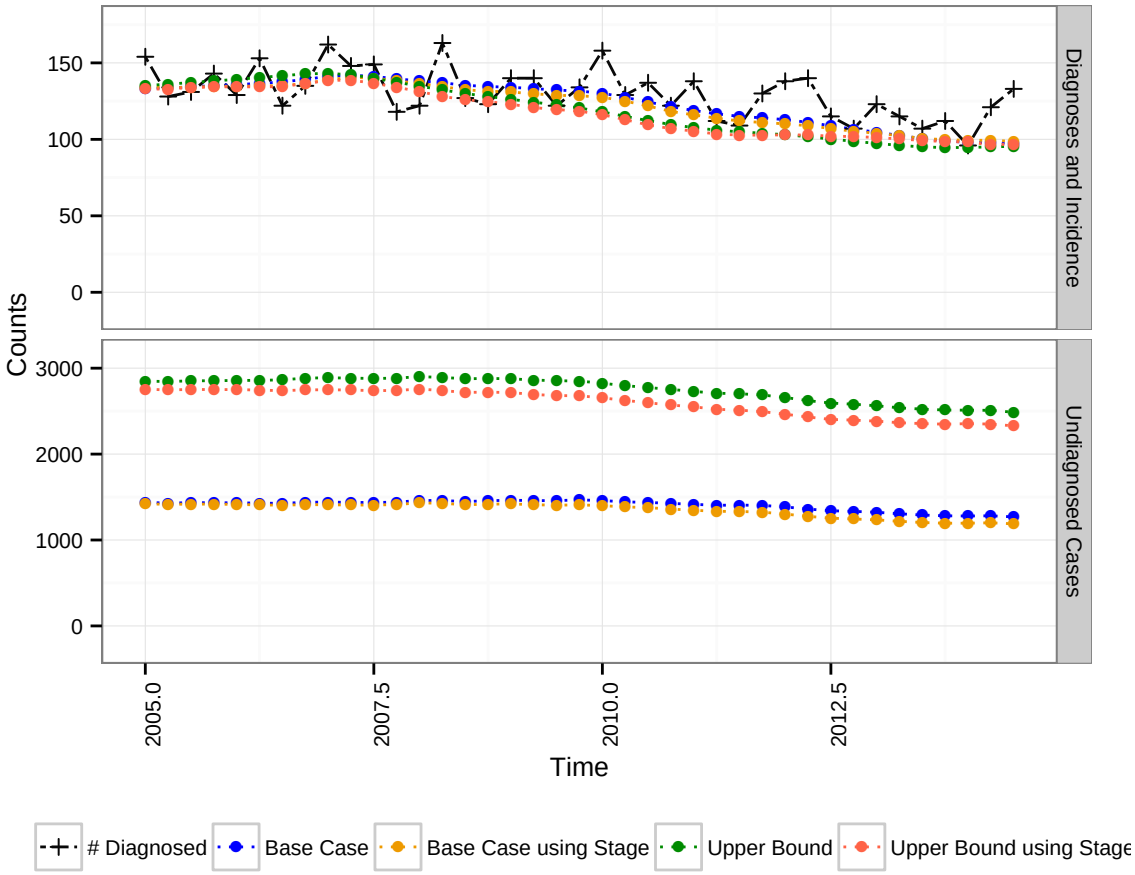

Figure 7: Observed diagnoses and estimated quarterly and undiagnosed counts over 2005-2014 in WA state, using stage-subgroup strata