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Identification of Persons with Incident Ocular Diseases Using Health Care Claims Databases

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Abstract

Purpose—To assess the extent to which incidence rates calculated for common ocular diseases by using claims data may be overestimated according to the length of the disease-free, look-back period used in the analysis.

Design—Retrospective longitudinal cohort analysis.

Methods—Billing records of 2457 persons continuously enrolled for 11 years in a managed-care network were searched for International Classification of Diseases (ICD-9-CM) diagnoses of cataract, open-angle glaucoma (OAG), nonexudative age-related macular degeneration (ARMD), and nonproliferative diabetic retinopathy (NPDR) at eye-care visits in the first half of 2001, the second half of 2010, and 2011. For each condition, incidence rates calculated by using look-back periods ranging from 0.5 to 9 years were compared with best estimates from a gold-standard period of 9.5 years.

Results—With a 1-year disease-free look-back period, incidence was overestimated by 260% for cataract, 135% for OAG, 209% for ARMD, and 300% for NPDR. Expanding the disease-free “look back” period to three years resulted in a reduction of incidence overestimation to 40% for cataract, 14% for OAG, 45% for ARMD, and 100% for NPDR. A 5-year look-back period yielded incidence rates overestimated by <30% for all four conditions.

Conclusions—In our claims-data analysis of four common ocular conditions, a disease-free interval 1 year insufficiently distinguished newly diagnosed from pre-existing disease, resulting

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All the authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis

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Data analysis: JDS, TSB

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in grossly overestimated incidence rates. Using look-back periods of 3–5 years, depending on the specific diagnosis, yielded considerably more accurate estimates of disease incidence.

In recent years a growing number of researchers have relied on data from large health care claims databases to study the epidemiology of diseases and trends in resource use and patient outcomes. Advantages of using large claims databases rather than other data sources include very large sample sizes (allowing the study of uncommon conditions); the ability to follow participants longitudinally, often for many years, to observe associations between exposures (e.g., medication use) and outcomes; the absence of reporting bias; improved accuracy, compared with patient self-report, on the types of medical conditions diagnosed, procedures performed, and medications prescribed¹; and the ability to study a patient sample drawn from a multitude of communities and providers practicing in various settings.²

In the medical literature, a considerable number of analyses have taken advantage of the longitudinal nature of claims data to identify incident case-patients with a given condition—that is, persons in whom the disease or adverse event of interest has been newly diagnosed, presumably signaling a relatively recent initial onset. Whether the researcher is seeking to examine a temporal relationship between exposures and outcomes, or the resource utilization or outcomes among persons with newly diagnosed disease, accurately distinguishing incident case-patients from nonincident case-patients (i.e., those in whom the condition was pre-existing) is paramount. However, incidence estimates can be inaccurate if persons in the database who seem to have a newly diagnosed condition actually received their initial diagnosis before their enrollment in the plan.

As a way to help distinguish incident from nonincident case-patients in their analyses, researchers can incorporate a *look-back* period—a disease-free period leading up to the *index date*, when observation for the presence or absence of disease begins. Persons with a diagnosis of the condition of interest in the look-back period would then be considered nonincident case-patients. For datasets in which all beneficiaries are continuously enrolled in the medical plan for the same length of time, a look-back period from the date of entry into the medical plan until the index date could be used. However, with most claims datasets, beneficiaries enter and leave the plan at different times, and there is no consistent length of time from beneficiaries' date of plan enrollment until the index date. By using a look-back period of a specified duration, for those who are enrolled in the plan for less than that length of time, the opportunity to have previously received a diagnostic code for the condition of interest is reduced relative to others enrolled for the entire look-back period. Such persons would thus have an increased likelihood of being misclassified as incident case-patients. An eligibility requirement of continuous enrollment in the plan for a specified duration before the index date would provide all enrollees with an equal opportunity to have previously received a diagnosis of the condition of interest.

A key question remains for researchers: How long must a disease-free look-back period be to adequately discriminate between incident and nonincident case-patients? With a longer look-back period, the likelihood of erroneously classifying patients with pre-existing disease as incident case-patients is reduced. Yet, as the look-back period increases, the pool of eligible participants decreases.

The optimal duration for a look-back period will likely vary from one condition to another. For example, persons with symptomatic or relatively serious conditions will probably be affected or otherwise concerned enough to seek frequent medical attention. For these sorts of conditions, a relatively long look-back period may be unnecessary. However, for relatively asymptomatic or less serious conditions, or for those that take longer to diagnose, a lengthier look-back period could be desirable. We explore how varying the duration of a

disease-free look-back period can affect the accuracy of incident-disease classifications for four relatively common ocular conditions.

METHODS

Data Source

The Clinformatics Data Mart database (previously named i3 InVision Data Mart) (Ingenix, Eden Prairie, MN) contains detailed, fully de-identified records of beneficiaries in a large nationwide managed-care network. We had data on beneficiaries receiving any eye care during January 1, 2001, through December 31, 2011. The dataset contains information on beneficiaries with at least one International Classification of Diseases (ICD-9-CM)³ code for any eye-related diagnosis (360–379.9); Current Procedural Terminology (CPT-4)⁴ code for any eye-related visit, or diagnostic or therapeutic procedure (65091–68899 or 92002–92499); or any claim submitted by an ophthalmologist or optometrist during the beneficiaries' time in the medical plan. We had access to the beneficiaries' medical claims (inpatient, outpatient, skilled nursing facility) for ocular and nonocular conditions, and sociodemographic information (age, sex, race, education, income). This database has previously been used in analyses involving ocular diseases.^{5,6} Because the data were de-identified, the University of Michigan determined that this study was exempt from requiring Institutional Review Board approval.

Eligibility

Our analysis included only persons continuously enrolled in the medical plan for the entire 11-year study period. Persons who exited and re-entered the plan were excluded because we could not determine whether any eye-related diagnoses were received during their time of nonenrollment. In addition, the beneficiary must have had one or more visits to an eye-care provider (ophthalmologist or optometrist) during (a) the first half of 2001 (January 1 to June 30), (b) the second half of 2010 (July 1 to Dec 31), and (c) 2011. These time intervals are consistent with ones used in a similar analysis in which incidence overestimations for selected nonocular diseases were assessed.⁷

Conditions of Interest

Our analysis evaluated four common ocular conditions: cataract, nonexudative age-related macular degeneration (ARMD), nonproliferative diabetic retinopathy (NPDR), and open-angle glaucoma (OAG). These conditions were selected because they are among the most common chronic ocular diseases affecting older Americans. Patients with these conditions were identified according to ICD-9-CM codes (Table 1). The Clinformatics database captures up to five ICD-9-CM diagnosis codes submitted for each patient encounter. A validation study found strong agreement between ICD-9-CM codes provided by eye-care providers and the medical records for several common ocular conditions, including OAG, cataract, and retinopathy.⁸

Identifying Prevalent Case-Patients

We first identified all enrollees with one or more codes for any of the four ocular conditions of interest from eye visits in the last six months of 2010 (July 1, 2010, through December 31, 2010). For the identified patients, we then determined whether they had another visit to an eye-care provider with a confirmatory diagnosis of the condition of interest in 2011. The rationale for requiring a visit to an eye-care provider is that these ocular conditions can be asymptomatic early in the disease course and a person may unknowingly have the condition without receiving an examination. Enrollees were considered *prevalent case-patients* if, according to billing codes, they had the condition of interest diagnosed in the second half of

2010 and again in 2011. Those without record of the condition during eye visits in the second half of 2010 and in 2011 were considered *confirmed non-case-patients* for that condition. Those who received a diagnosis in 2010 but no confirmatory diagnosis in 2011 were excluded, since we could not confirm the presence of the condition; similarly, we excluded those in whom the condition was first diagnosed in 2011.

Identifying Incident Case-Patients

We considered *potential incident case-patients* to be persons receiving a diagnosis of the condition of interest in the second half of 2010 and a confirmatory diagnosis in 2011. *Confirmed incident case-patients* were defined as the subset of these persons who had not received the diagnosis of the condition of interest in the 9.5-year look-back period from January 2001 through June 2010. These case-patients served as our gold standard, as they were known to lack the disease until the second half of 2010, when an initial diagnosis was made.

Potential incident case-patients were then confirmed or not by using look-back periods of varying lengths. Eighteen such periods were considered. The shortest period was 6 months; in each subsequent consecutive period, 6 months were added to the previous period's duration until the longest period reached 9 years.⁷

Determining Incidence Overestimation

For each ocular disease, we compared the incidence estimates generated by using the 18 look-back periods with our gold-standard best estimate. For each condition and look-back period, the degree of overestimation was calculated by taking the difference between the number of potential incident case-patients and the number of incident case-patients estimated by the gold standard and dividing by the number of incident case-patients. The degree of overestimation was multiplied by 100 and presented as a percentage.

RESULTS

A total of 2457 enrollees (mean age $\pm$ standard deviation, 49.7 ± 15.1 years) met the inclusion criteria. Among the eligible enrollees, 1472 (59.9%) were female, and for those with documented information on race/ethnicity, the sample included 2010 whites (81.8%), 100 blacks (4.1%), 66 Latinos (2.7%), and 47 Asian Americans (1.9%). The sample had 793 college graduates (32.2%) and 379 persons with an annual income exceeding \$125 000 (15.4%).

Open-Angle Glaucoma

Among the eligible enrollees, 465 (19%) received OAG diagnostic codes at eye-care visits in the second half of 2010 and in 2011. Eighteen-hundred seventy individuals (76%) had no OAG record in that 1.5-year span. The remaining 122 enrollees were excluded from this particular analysis because an OAG diagnosis was noted at least once in July through December 2010 or in 2011 but not in both periods.

Of the 465 persons with confirmed OAG, 14 (3%) had no previous diagnosis of OAG, during January 2001 through June 2010. By using a 1-year disease-free interval, OAG incidence is overestimated by 135%. With a 2-year period, overestimation drops to 43%, and with 3 years it decreases further to 14%, where it levels off for the subsequent intervals tested (Figure 1 and Table 2).

Among the 1870 persons with no record of OAG in the second half of 2010 and none in 2011, 157 (8.4%) had one or more records of OAG during eye-care visits between January 1, 2001, and June 30, 2010.

Cataract

Among the eligible enrollees, 434 persons (18%) had cataract codes in the second half of 2010 and in 2011. Sixteen-hundred twenty-five persons (66%) had no such record in both periods. The remaining 398 enrollees were excluded from this analysis because they had a cataract diagnosis in only one of these two periods.

Of those with confirmed cataract, 43 (10%) had no previous cataract diagnosis during January 2001 through June 2010. Cataract incidence is overestimated by 260% with a 1-year disease-free interval, by 84% with a 2-year interval, and by 40% with a 3-year interval. With a 5-year look-back period, the incidence overestimation drops to 19%, and it decreases slowly thereafter for the subsequent periods tested (Figure 2 and Table 2). Among the 1625 persons with no record of cataract from July 2010 through December 2011, 551 enrollees (33.9%) had at least one previous record of the condition (i.e., before July 2010). Of note, 240 of these 551 enrollees (43.6%) also had codes for pseudophakia or aphakia, which may account for their nonreceipt of a cataract code in mid-2010 through December 2011.

Nonexudative Age-Related Macular Degeneration

One-hundred three patients (4%) had codes for ARMD in the second half of 2010 and in 2011. Twenty-two hundred fifty persons (92%) had no such record during eye visits in those two consecutive periods. The remaining persons (n=104) were excluded from this analysis because they received an ARMD diagnosis in only one of these periods.

Of the 103 persons with confirmed ARMD, 11 (11%) had no record of the condition before July 2010. By using a 1-year disease-free interval, ARMD incidence is overestimated by 209%; by using 2 and 3 years, respectively, the incidence is overestimated by 82% and 45%. With a 5-year look-back period, the overestimation decreases to 27%, and it drops off slowly from there (Figure 3 and Table 2).

Among the 2250 persons with no diagnosis of ARMD from July 2010 through 2011, 146 (6.5%) had such a diagnostic code during 2001 through June 2010.

Nonproliferative Diabetic Retinopathy

Seventy-five patients (3%) had a diagnosis of NPDR in the second half of 2010 and a confirmatory diagnosis in 2011. Twenty-three hundred six persons (94%) had no record of NPDR from July 2010 through December 2011. The remaining 76 enrollees had an NPDR diagnosis in the second half of 2010 or sometime in 2011, but not in both periods; they were excluded from this analysis.

Six of the 75 persons with confirmed NPDR (8%) had no previous diagnosis of NPDR. With a 1-year disease-free interval, NPDR incidence is overestimated by 300%. As the look-back duration extends to 2 and then 3 years, the overestimation decreases to 183% and 100%, respectively. With a 5-year look-back period, the incidence overestimation falls dramatically to 17%, where it remains steady for the longer durations tested (Figure 4 and Table 2).

Among the 2306 persons without diagnostic codes for NPDR from July 2010 through December 2011, 105 enrollees (4.6%) had at least one previous NPDR diagnosis. Figure 5, a composite figure, shows the degree of incidence overestimation for each ocular condition of interest relative to look-back periods. Supplemental Table 1, available at AJO.com, provides

the sociodemographic characteristics of enrollees with incident disease based on our gold-standard criteria and the characteristics of those who composed the overestimation category. For the four conditions considered, sociodemographic characteristics mostly did not differ between patients with incident disease according to our gold-standard criteria and those in the overestimation category, except that persons with nonincident cataract were older, on average, than persons with incident cataract ($p=0.02$).

DISCUSSION

Results of our claims-data analysis of selected common ocular diseases suggest that a disease-free interval, or look-back period, of 12 months or less may be insufficiently long to accurately identify persons with newly diagnosed conditions. With such a limited interval, disease incidence can be grossly overestimated for OAG (by 135%), cataract (260%), nonexudative ARMD (209%), and NPDR (300%). By extending the disease-free interval to 3 years, overestimation of the incidence is improved considerably for the first three of these conditions (dropping to 14–45%), but remains relatively high for NPDR (at 100%). Starting with a 5-year look-back period, the level of overestimation essentially remains low and steady.

Although numerous studies use claims data to identify persons with incident ophthalmic disease, no universally accepted criteria exist to distinguish incident from nonincident case-patients in such analyses. The durations of disease-free intervals in previous studies have ranged from 6 months to 3 years;^{9–14} in our previous work, 1-year intervals were used.^{13,14} In a sensitivity analysis of exudative ARMD, Sloan and colleagues¹¹ found that lengthening the disease-free interval from 2 to 3 years affected incidence estimates only nominally. Using algorithms, Quantin and colleagues¹⁵ found a 5-year look-back interval to be insufficiently long for accurate estimation of incident colorectal cancer.

Lengthening the duration of the disease-free interval used in a claims-data analysis can help to more accurately identify incident case-patients; however, doing so often limits the number of patients who will be eligible for the analysis and the length of time during which patients can be followed. For example, with 7 years' worth of longitudinal claims data and imposition of a 5-year disease-free look-back period, the eligible plan enrollees could be followed for possible development of the condition for no more than 2 years. If the condition takes considerable time to manifest, this monitoring period may be inadequate. Moreover, such an analysis would necessarily be restricted to only those enrollees with continuous plan enrollment throughout the 5-year look-back period (to help ensure that all study participants have an equal opportunity to be identified as incident case-patients), potentially narrowing the sample size substantially. Finally, some databases do not have 7 years of data available.

Obtaining a consensus among ophthalmic researchers on an acceptable disease-free interval to use in claims-data analyses would allow studies using different data sources to be compared more readily. An acceptable, agreed-on duration need not be the same for all ocular conditions. For example, conditions that are often relatively acute and symptomatic in nature, such as endophthalmitis, may require less look-back time than other conditions with a more insidious onset and course, such as nonexudative ARMD.

We used methods similar to those reported by Abbas and coworkers⁷ for a comparison of incidence overestimations among selected systemic conditions, including diabetes mellitus, colon cancer, and heart failure, by using a German insurance database. Similar to but less dramatic than our findings, these investigators observed that a 1-year look-back period yielded incidence figures that were overestimated by 23–43%. Factors contributing to the

higher incidence overestimation in our analysis compared with the earlier study may be differences in (a) study methods (the disease-free intervals were 9.5 years in our study vs. 8 years in the earlier study), (b) providers' coding habits between the two countries, and (c) the severity of the conditions examined.

A relatively small proportion of patients in our study (<10%) who visited an eye-care provider at least twice in 2010–2011 and had no record of OAG, nonexudative ARMD, or NPDR during those visits had received a diagnosis of the condition at an earlier time in the plan. Such persons, who presumably had the disease of interest, could easily have been misclassified as non-case-patients, causing the overall incidence to be underestimated. Our findings suggest that in claims-data calculations of disease incidence, underestimation is not nearly as common as overestimation is, at least for the ocular conditions we studied. Without access to the patients' medical records, we cannot know for certain why patients who had received a diagnosis of the ocular disease in earlier years had no diagnostic code for the same condition during their eye-care visits in mid-to-late 2010 and in 2011.

Researchers seeking to identify patients with newly diagnosed disease in claims datasets should consider the influence of requiring visits to eye-care providers during the disease-free interval. Because conditions like OAG, NPDR, and nonexudative ARMD are often relatively asymptomatic early on, accurate identification of persons with and without these conditions can be improved considerably by requiring professional eye-care examinations. In our analysis at least three visits to eye-care providers were required (1 visit each in early-to-mid-2001, mid-to-late-2010, and 2011). Requiring even more such visits over the 11-year study period would have improved the ability to identify which patients did (or did not) have a particular condition and approximately when the onset occurred. However, because most patients who are not already being followed regularly for a chronic ocular condition would not ordinarily seek regular eye care, an eligibility requirement of very frequent eye-care visits could result in biased estimates of disease incidence and prevalence.

Another strategy to enhance the likelihood of accurately identifying patients with the disease of interest in claims databases is to require not only diagnostic billing codes but also codes for treatment of the condition. For example, to identify incident OAG case-patients, researchers could require an OAG diagnosis and record of a medical or surgical intervention for OAG. Such an approach may be unhelpful, however, with ocular conditions like nonexudative ARMD or NPDR, in which patients often can be managed with interventions not necessarily captured by claims data (e.g., use of an Amsler Grid at home or sunglasses).

Our study has several limitations. First, like all analyses that rely on claims data to identify patients with a disease, our study results could be affected by misdiagnosis or miscoding.² Without access to the medical records, we cannot fully verify the presence or absence of disease in the study participants. Of note, however, a study that used medical records to verify billing-code diagnoses found that, in general, the use of billing records accurately identified patients with common ocular conditions, including cataract, OAG, and nonexudative ARMD.⁸ Second, the best gold standard we could use, given our dataset, to identify incident case-patients was a 9.5-year disease-free period, spanning January 2001 through June 2010. Although this time frame is relatively long, we ideally would use an even longer disease-free interval, to determine with even greater certainty when each patient received her initial diagnosis of interest. Third, all the participants had health insurance; our results may be nongeneralizable to persons with other forms of insurance or persons who are uninsured or underinsured. Fourth, we studied only four common ocular diseases. Additional work is needed to assess possible incidence overestimation with other ocular and nonocular conditions. Finally, this particular claims database captures only the first five ICD-9-CM billing codes assigned at a given encounter. If the condition of interest was not

listed as one of the top five codes for a given encounter, no record of the condition would exist for that visit. However, among the 100 010 total encounters for all 2457 enrollees during the study period, 99 786 encounters (99.8%) had fewer than five ICD-9-CM codes listed; moreover, among the 224 encounters for which five codes were recorded, 151 of them referenced at least one of the conditions of interest. Only 0.07% of encounters had five diagnostic codes listed but none for the conditions of interest (data not shown).

This study demonstrates the capacity of using longitudinal health care claims data to accurately identify patients with incident ocular disease. Our study also highlights the effect of the length of the disease-free look-back period on the estimate of disease incidence. By using data from studies such as this one, we encourage health services researchers in ophthalmology to try to reach consensus on recommended durations for disease-free look-back periods that would optimize the accuracy of incidence calculations for various common ocular diseases. A benefit of a widespread adoption of such recommended methods across future epidemiologic analyses would be the ability to directly compare results from different studies. On the basis of the findings of this analysis, we strongly encourage the use of a look-back period of at least 3–5 years for claims-data analyses that estimate the incidence of those common ocular diseases.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Overestimation of Enrollees with Incident Open-Angle Glaucoma Using Different Disease Free “Look Back” Periods Using Health Care Claims Data

Total enrollees eligible for analysis = 465

To determine the presence or absence of incident disease, all eligible enrollees were in the plan all 11 years, and had 3 or more visits to an eye care provider including at least one during January 1, 2001 - June 30, 2001, at least one during June 30, 2010 and January 1, 2011, and at least one visit during 2011.

Figure 2.

Overestimation of Enrollees with Incident Cataract Using Different Disease Free “Look Back” Periods Using Health Care Claims Data

Total enrollees eligible for analysis = 434

To determine the presence or absence of incident disease, all eligible enrollees were in the plan all 11 years, and had 3 or more visits to an eye care provider including at least one during January 1, 2001 - June 30, 2001, at least one during June 30, 2010 and January 1, 2011, and at least one visit during 2011.

Figure 3.

Overestimation of Enrollees with Incident Non-exudative Macular Degeneration Using Different Disease Free “Look Back” Periods Using Health Care Claims Data

Total enrollees eligible for analysis = 103

To determine the presence or absence of incident disease, all eligible enrollees were in the plan all 11 years, and had 3 or more visits to an eye care provider including at least one during January 1, 2001 - June 30, 2001, at least one during June 30, 2010 and January 1, 2011, and at least one visit during 2011.

Figure 4.

Overestimation of Enrollees with Incident Non-Proliferative Diabetic Retinopathy Using Different Disease Free “Look Back” Periods Using Health Care Claims Data

Total enrollees eligible for analysis = 75

To determine the presence or absence of incident disease, all eligible enrollees were in the plan all 11 years, and had 3 or more visits to an eye care provider including at least one during January 1, 2001 - June 30, 2001, at least one during June 30, 2010 and January 1, 2011, and at least one visit during 2011.

Figure 5.
Overestimation of Enrollees with Common Ocular Diseases Using Different Disease Free “Look Back” Periods Using Health Care Claims Data
OAG = open-angle glaucoma; AMD = age-related macular degeneration; NPDR = non-proliferative diabetic retinopathy

Table 1

International Classification of Disease (ICD-9-CM) Codes Used to Identify Enrollees with Each Ocular Condition

Condition	Billing Codes Used
Cataract	366, 366.0, 366.00, 366.01, 366.02, 366.03, 366.04, 366.09, 366.1, 366.10, 366.12, 366.13, 366.14, 366.15, 366.16, 366.17, 366.18, 366.19, 366.41, 366.45
Non-exudative macular degeneration	362.50, 362.51, 362.57
Non-proliferative diabetic retinopathy	362.01, 362.03, 362.04, 362.05, 362.06
Open-angle glaucoma	365.1, 365.10, 365.11, 365.12, 365.15

Table 2
Impact of Disease Free Interval Length on Incidence Overestimation for Enrollees with Four Common Ocular Diseases

Disease Free Interval Length	Open-angle glaucoma		Non-exudative macular degeneration		Non-proliferative diabetic retinopathy		Cataract	
	N*	Incidence overestimation	N*	Incidence overestimation	N*	Incidence overestimation	N*	Incidence overestimation
6 months	86	514%	50	355%	31	417%	264	514%
12 months	33	136%	34	209%	24	300%	155	260%
18 months	24	71%	21	91%	19	217%	107	149%
24 months	20	43%	20	82%	17	183%	79	84%
30 months	17	21%	18	64%	15	150%	68	58%
36 months	16	14%	16	45%	12	100%	60	40%
42 months	16	14%	16	45%	12	100%	56	30%
48 months	16	14%	15	36%	9	50%	55	28%
54 months	16	14%	14	27%	9	50%	52	21%
60 months	16	14%	14	27%	7	17%	51	19%
66 months	16	14%	14	27%	7	17%	50	16%
72 months	16	14%	13	18%	7	17%	50	16%
78 months	16	14%	13	18%	7	17%	47	9%
84 months	16	14%	12	9%	7	17%	45	5%
90 months	16	14%	11	0%	7	17%	44	2%
96 months	16	14%	11	0%	7	17%	43	0%
102 months	15	7%	11	0%	7	17%	43	0%
108 months	14	0%	11	0%	7	17%	43	0%
Gold standard	14		11		6		43	

* N is the number of potential incident cases. These cases were diagnosed with the disease of interest during the second half of 2010 and had a confirmatory diagnosis in 2011, and were disease free prior to that time using the disease free intervals indicated. For example, the number of potential incident cases of open-angle glaucoma using a 6 month disease free period is 86 enrollees. This is compared to the best incidence estimate (the Gold Standard, defined as those with a confirmed diagnosis in 2010 and 2011, along with no disease occurrence from Jan 1, 2001 – June 30, 2010) yielding an incidence overestimation of $(86-14)/14 = 514\%$.