Paper CC-37

Tips for Identifying Patient Characteristics Associated with Diagnostic Concordance between Two Measures Using SAS®

Seungyoung Hwang, Johns Hopkins University Bloomberg School of Public Health

ABSTRACT

Sensitivity, specificity, and positive and negative predictive values are often used in validation studies. However, few have examined what patient characteristics are associated with diagnostic concordance between two measures of interest. This paper provides an in-depth analysis, with some explanation of the SAS code, to identify sociodemographic and clinical characteristics associated with diagnostic concordance between two measures of depression using SAS. Examples of using the GLIMMIX procedure are drawn from clinical data that I recently published in the *American Journal of Geriatric Psychiatry* (1).

CASE STUDY: DEPRESSTION DIAGNOSIS AND MEDICARE CLAIMS

The Prevention of Suicide in Primary Care Elderly: Collaborative Trial (PROSPECT) was a cluster-randomized controlled trial designed to compare an algorithm-based intervention with usual care to reduce major risk factors of suicide (e.g., depression) for older primary care patients (2, 3). A cohort of 742 primary care patients in PROSPECT was linked to Medicare claims data. Depression was assessed based on structured clinical interviews over the 2-year study period (gold standard) and based on Medicare claims from the same 2-year window.

The variables are as follows:

studyid   is the study id.

practice   is the practice number for each patient.

scid_depr   1 = depression based on structured clinical interviews over the 2-year study period; 0 = no depression.

medi_depr   1 = depression based on Medicare claims over the 2-year study period; 0 = no depression.

age70   1 = aged over 70 at baseline; 0 = aged 70 or younger.

female   1 = female; 0 = male.

minority   1 = ethnic minority (ethnicity other than non-Hispanic white); 0 = other.

edu12   1 = educated 12 years or more; 0 = educated less than 12 years.

married   1 = married; 0 = other.

smoker   1 = smoker; 0 = non-smoker.

MMSE   1 = cognitively impaired (Mini-Mental State Exam score < 23); 0 = cognitively not impaired (MMSE ≥ 23).

HDRS   1 = (Hamilton Depression Rating Scale > 10); 0 = (HDRS ≤ 10).

si   1 = suicidal ideation; 0 = no suicidal ideation.

CVD   1 = cardiovascular disease; 0 = no cardiovascular disease.

diabetes   1 = diabetes; 0 = no diabetes.

cancer   1 = cancer; 0 = no cancer.

COPD   1 = chronic pulmonary disease; 0 = no chronic pulmonary disease.

PCP   is the number of primary care physician visits.

I sorted 742 participants into four groups based on the two measures of depression in **Table 1**. Measures of agreement (sensitivity, specificity) are shown in **Table 1** as well.

Table 1. Relationship between depression based on SCID interview and claim of depression in Medicare data.

	Depression based on SCID interview	Does not meet criteria based on SCID interview	Totals
Depression based on Medicare claims	198 (true positives)	33 (false positives)	231
No Medicare claims for depression	276 (false negatives)	235 (true negatives)	511
Totals	474	268	742
	Sensitivity = 41.8%	Specificity = 87.7%	

Note: This table was adapted from Hwang et al. 2015 (1).

SCID = Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, 4th Edition.

Specificity was high (87.7%), but sensitivity was substantially lower (41.8%). In other words, 87.7% of those who did not meet criteria for depression had no Medicare claim of depression, whereas only 41.8% of those who met criteria for depression had a corresponding Medicare claim.

Why did 276 patients (false negatives) have no Medicare claims of depression even though they all met criteria for depression? And why did 33 patients (false positives) have depression claims even though they all did not meet criteria for depression?

In this regards, I compared the patient characteristics of false negatives with those of true positives; in separate models, I compared the characteristics of false positives with those of true negatives.

To do this, I run the following program:

```
* ==========  False Negatives vs. True Positives (reference)  ========== *;
PROC GLIMMIX DATA=MyData1;
    CLASS practice age70(ref='0') female(ref='0') minority(ref='0')
          edu12(ref='0') married(ref='0') smoker(ref='0') MMSE(ref='0')
          HDRS(ref='0') si(ref='0') CVD(ref='0') diabetes(ref='0')
          cancer(ref='0') COPD(ref='0');
    MODEL medi_depr(event='0') = age70 female minority edu12 married smoker
          MMSE HDRS si CVD diabetes cancer COPD PCP
          / DIST=binary SOLUTION ODDSRATIO;
```

```
        RANDOM intercept / SUBJECT=practice;
        ODS OUTPUT OddsRatios=Table2;
        WHERE scid_depr = 1;
RUN;


PROC PRINT DATA=Table2 NOOBS;
        FORMAT Estimate 4.2
               Lower    4.2
               Upper    5.2;
        VAR Estimate Lower Upper;
RUN;


* ===========  False Positives vs. True Negatives (reference)  =========== *;

PROC GLIMMIX DATA=MyData1;
        CLASS practice age70(ref='0') female(ref='0') minority(ref='0')
              edu12(ref='0') married(ref='0') smoker(ref='0') MMSE(ref='0')
              HDRS(ref='0') si(ref='0') CVD(ref='0') diabetes(ref='0')
              cancer(ref='0') COPD(ref='0');
        MODEL medi_depr(event='1') = age70 female minority edu12 married smoker
              MMSE HDRS si CVD diabetes cancer COPD PCP
              / DIST=binary SOLUTION ODDSRATIO;
        RANDOM intercept / SUBJECT=practice;
        ODS OUTPUT OddsRatios=Table3;
        WHERE scid_depr = 0;
RUN;


PROC PRINT DATA=Table3 NOOBS;
        FORMAT Estimate 4.2
               Lower    4.2
               Upper    5.2;
        VAR Estimate Lower Upper;
RUN;
```

The RANDOM statement is specified in order to adjust standard errors for within-practice clustering in the logistic random effects regression. The PROC PRINT statement was used to print the final results (i.e., odds ratios and associated 95% confidence intervals) with two decimal places.

Combined results are shown below in **Table 2**.

I found that persons of an ethnic minority were about twice as likely as nonminority to be false negatives, whereas smokers and persons with greater depressive symptoms (higher HDRS scores), cardiovascular disease, and more primary care physician office visits were less likely to be classified as false negatives.

In contrast, persons of an ethnic minority were less likely to be false positives, but persons with chronic pulmonary disease were more likely to be classified as false positives.

Table 2. Comparison of patient characteristics.

Characteristics	FN vs. TP (reference) aOR (95% CI)	FP vs. TN (reference) aOR (95% CI)
Sociodemographic characteristics		
Age > 70 years	0.79 (0.50 - 1.25)	1.46 (0.44 - 4.85)
Women	0.64 (0.40 - 1.18)	1.05 (0.36 - 3.06)
Ethnic minority	**2.11 (1.17 - 3.80)**	**0.25 (0.07 - 0.90)**
Education (≥ 12 years)	1.24 (0.73 - 2.10)	0.99 (0.31 - 3.12)
Married	1.16 (0.68 - 1.96)	1.13 (0.41 - 3.08)
Habits		
Current smoker	**0.55 (0.30 - 0.99)**	2.55 (0.48 - 13.66)
Cognition and depression		
MMSE score (< 23)	0.57 (0.22 - 1.46)	2.28 (0.50 - 10.37)
HDRS score (> 10)	**0.47 (0.26 - 0.84)**	4.97 (0.91 - 27.15)
Suicidal ideation	0.90 (0.53 - 1.54)	0.70 (0.07 - 7.18)
Medical conditions		
Cardiovascular disease	**0.28 (0.16 - 0.50)**	2.78 (0.55 - 13.95)
Diabetes	1.70 (0.98 - 2.93)	1.89 (0.74 - 4.85)
Cancer	0.66 (0.35 - 1.28)	1.96 (0.67 - 5.77)
Chronic pulmonary disease	0.70 (0.41 - 1.19)	**3.84 (1.55 - 9.51)**
Medical services		
PCP office visits	**0.90 (0.87 - 0.94)**	1.05 (0.99 - 1.12)

Note: This table was adapted from Hwang et al. 2015 (1).

aOR = Adjusted Odds Ratio; CI = Confidence Interval; MMSE = Mini-Mental State Examination;

HDRS = Hamilton Depression Rating Scale.

DISCUSSION

Recent decades have seen tremendous reports of validation studies in various academic fields. Measure of agreement such as sensitivity, specificity, and positive and negative predictive values are often used. However, few have examined what patient characteristics are associated with diagnostic concordance between two measures of interest.

In this study, logistic regressions with random effects were used to examine how well Medicare claims of depression agree with structured clinical assessments of depression obtained from older primary care patients in PROSPECT follow-up study. The random statement within the PROC GLIMMIX procedure in SAS was used so that variance estimates, confidence intervals, and p values were adjusted for within-practice clustering. I found that 87.7% of those who did not meet criteria for depression had no Medicare claim of depression, whereas only 41.8% of those who met criteria for depression had a corresponding

Medicare claim. Interestingly, minority older adults who met criteria for depression were less likely and older adults with medical comorbidity who did not meet criteria for depression more likely to have a Medicare claim of depression.

REFERENCES

1.   Hwang S, Jayadevappa R, Zee J, et al: Concordance Between Clinical Diagnosis and Medicare Claims of Depression Among Older Primary Care Patients. The American journal of geriatric psychiatry : official journal of the American Association for Geriatric Psychiatry 2015; 23:726-734
2.   Bruce ML, Ten Have TR, Reynolds CF, 3rd, et al: Reducing suicidal ideation and depressive symptoms in depressed older primary care patients: a randomized controlled trial. JAMA : the journal of the American Medical Association 2004; 291:1081-1091
3.   Gallo JJ, Morales KH, Bogner HR, et al: Long term effect of depression care management on mortality in older adults: follow-up of cluster randomized clinical trial in primary care. BMJ 2013; 346:f2570

ACKNOWLEDGMENTS

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at:

Seungyoung Hwang, MS, MSE, GStat[®]

Biostatistician, Department of Mental Health,

DrPH Student, Department of Health Policy and Management

Bloomberg School of Public Health

Johns Hopkins University

624 North Broadway, Hampton House 880

Baltimore, MD 21205

Phone: 410-440-2040

Email: shwang25@jhu.edu