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Comparison of AUDIT-C Collected via Electronic Medical Record and Self-Administered Research Survey in HIV Infected and Uninfected Patients

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Conflicts of interest

The manuscript has not been previously published and is not being considered for publication elsewhere. The authors have all approved the manuscript and have no conflicts of interest to declare.

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Abstract

Background—Using electronic medical record (EMR) data for clinical decisions, quality improvement, and research is common. While unhealthy alcohol use is particularly risky among HIV infected individuals (HIV+), the validity of EMR data for identifying unhealthy alcohol use among HIV+ is unclear. Among HIV+ and uninfected, we: 1) assess agreement of EMR and research AUDIT-C at validated cutoffs for unhealthy alcohol use; 2) explore EMR cutoffs that maximize agreement; and 3) assess subpopulation variation in agreement.

Methods—Using data from the Veterans Aging Cohort Study (VACS), EMR AUDIT-C cutoffs of 2+, 3+, and 4+ for men (2+ and 3+ for women) were compared to research AUDIT-C 4+ for men (3+ for women). Agreement was compared by demographics, HIV, hepatitis C infection, and alcohol related diagnosis.

Results—Among 1,082 HIV+ and 1,160 uninfected men, 14% and 22% had an EMR and research AUDIT-C 4+, respectively. Among 32 HIV+ and 115 uninfected women, 9% and 14% had an EMR and research AUDIT-C 3+. For men, EMR agreement with the research AUDIT-C 4+ was highest at a cutoff of 3+ (kappa = 0.49). For women, EMR agreement with AUDIT-C 3+ was highest at a cutoff of 2+ (kappa = 0.60). Moderate agreement was consistent across subgroups.

Conclusions—EMR AUDIT-C underestimates unhealthy alcohol use compared to research AUDIT-C in both HIV+ and uninfected individuals. Methods for improving quality of clinical screening may be in need of investigation. Researchers and clinicians may consider alternative EMR cutoffs that maximize agreement given limitations of clinical screening.

Keywords

Alcohol consumption; population-based screening; AUDIT-C; electronic health record; veterans; HIV

1. INTRODUCTION

Using electronic medical record (EMR) data for clinical decisions, quality improvement, and research is common; however, the validity of EMR data for identifying unhealthy alcohol use among those infected with HIV (HIV+) is unclear. Unhealthy alcohol use includes any amount of drinking above “low risk” drinking and ranges from risky drinking to alcohol use disorders (Bradley et al., 2009; Saitz, 2005). Unhealthy alcohol use is common among those with HIV with estimates of 8% for alcohol abuse (Galvan et al., 2002; McGinnis et al., 2013), and 20% to 41% for hazardous use (Conigliaro et al., 2003; Justice et al., 2016; McGinnis et al., 2013). Among HIV+ individuals, unhealthy alcohol use has been associated with non-adherence to antiretroviral therapy (ART; Hendershot et al., 2009), worse HIV disease (Hahn et al., 2010), mortality and physiological frailty (Justice et al., 2016) and worse quality of care (Korthuis et al., 2012). Some HIV+ patients do not take ART in advance of drinking to avoid medication interactions (Kalichman et al., 2015; Bilal et al., 2016). Further, intoxication, which occurs at lower levels of drinking for HIV+ relative to HIV- patients (McGinnis et al., 2016), is associated with increased risky sexual behavior (Cook et al., 2006; Stall et al., 1986; Scott-Sheldon et al., 2013, 2016), which may increase risk of HIV transmission (Cook et al., 2006; Petry et al., 1999; Stall et al., 1986; Shuper et al., 2010). HIV+ individuals may be more sensitive to the effects of alcohol (McCance-Katz et al., 2012; McGinnis et al., 2016) and experience increased mortality and physiologic injury at lower levels of alcohol use compared to those uninfected (Justice et al., 2016). Identifying unhealthy alcohol use among HIV+ can provide an opportunity for intervention, and guide clinical quality improvement and research efforts designed to provide tailored patient care.

The Alcohol Use Disorders Identification Test – Consumption (AUDIT-C) questionnaire has been routinely collected and entered into the EMR system in the Veterans Health Administration (VHA) since 2006 (Bradley et al., 2006) and provides a source of information regarding unhealthy alcohol use for a large cohort of HIV+ and uninfected veterans. However, studies have found that the prevalence of unhealthy alcohol use is lower when based on EMR AUDIT-C, which are collected primarily face-to-face in a clinical setting (Williams et al., 2015), compared to AUDIT-C collected via mailed surveys (Bradley et al., 2011; Hawkins et al., 2007, Lapham et al., 2013). Lower prevalence using EMR AUDIT-C compared to self-administered survey AUDIT-C could be due to the mostly face-to-face mode of collection of EMR data as there is: 1) documented variation in how AUDIT-C is administered and documented by clinic staff including skipping the 3rd AUDIT-C item and altering items (and potential response options) in attempt to enhance patient comfort (Williams et al., 2015); and 2) social desirability bias inherent in face-to-face collection of sensitive issues - disclosure of sensitive information is lower with face-to-face administration compared to paper administration (Bowling, 2005). In contrast, wording and response items on paper surveys are fixed and consistent and responses may be less subject to social desirability bias, especially if the information is collected confidentially.

Patient comfort and social desirability bias may be an even greater issue in HIV clinics due to potential implications or consequences for reporting alcohol use. Treatment for conditions that are commonly comorbid with HIV, such as HCV, have traditionally been

contraindicated for patients who use alcohol, which may be a disincentive for accurately reporting alcohol use in clinical settings. Therefore, agreement of EMR with research AUDIT-C screening results may vary by HIV status and this has not been previously examined. Similarly, screening results may vary by HCV, race/ethnicity, site, and/or alcohol related diagnosis.

The main goals of the current study were to 1) assess agreement of EMR and research AUDIT-C at validated cutoffs for identifying unhealthy alcohol use; 2) explore EMR AUDIT-C cutoffs that maximize agreement with research AUDIT-C; and 3) assess subpopulation variation in agreement.

2. MATERIALS AND METHODS

2.1 Veterans Aging Cohort 8 Site Study (VACS-8)

We used data from the VACS 8 Site Study (VACS-8) which has been described in detail previously (Justice et al., 2006). Briefly, VACS-8 is a prospective cohort study conducted at eight VHA facilities in the United States (Atlanta, Georgia; Baltimore, Maryland; Bronx, New York; Houston, Texas; Los Angeles, California; New York City, New York; Pittsburgh, Pennsylvania and Washington, District of Columbia). Recruitment and enrollment in VACS began in June, 2002 and is ongoing. HIV+ individuals are recruited from Infectious Disease clinics at participating sites. Uninfected controls are recruited from General Internal Medicine clinics at the same sites, and are targeted to match the demographics of the Infectious Diseases clinics by 5-year age blocks, race/ethnicity, and year of active VHA healthcare use. After patients were consented to the study and at annual follow-ups, participants completed a comprehensive self-administered paper survey that includes the AUDIT-C. Usually surveys were completed before, after, or in between appointments; sometimes patients took the survey and returned it to the research coordinator at a later time. The coordinator was not typically present when the subjects were completing the surveys and in some situations (the minority of the time) the follow-up surveys were mailed to the participants. The study consent informs participants that their survey responses will remain confidential. For this analysis, we include AUDIT-C data from a VACS participant's first completed survey between October, 2007 and September, 2012. This could be the baseline survey or follow-up waves 4, 5, and 6 for previously enrolled participants. These survey data are referred to as "research AUDIT-C".

2.2 Veterans Health Administration (VHA) EMR Data

We used AUDIT-C data available through the VHA Corporate Data Warehouse (CDW) from October, 2007 to September, 2012. The CDW is a national repository that incorporates data from clinical and administrative systems into one standard database structure and is described in detail elsewhere (McGinnis et al., 2011). AUDIT-C and information on a variety of health behaviors (such as smoking and depressive symptoms) are collected nationally using clinical reminder prompts to clinicians (Bradley et al., 2011; McGinnis et al., 2011; Williams et al., 2015). We identified an EMR AUDIT-C reported within 90 days before or after the research AUDIT-C. The 90 day window was utilized because it was

previously reported to provide similar results as narrower timeframes (Bradley et al., 2011). These data are referred to as “EMR AUDIT-C.”

2.3 Analyses

We describe demographic characteristics and AUDIT-C results by HIV status for VACS participants with an EMR AUDIT-C within 90 days of a research AUDIT-C. The t-test was used to compare age by HIV status and chi-square tests were used to compare categorical variables by HIV status.

For men, we assessed agreement between EMR AUDIT-C and research AUDIT-C 4+ using agreement percent, sensitivity, specificity, and kappa statistics. Because prior research found there is under-reporting of unhealthy alcohol use with EMR AUDIT-C, we evaluated EMR AUDIT-C cutoffs of 2+, 3+, and 4+. The threshold of greater than or equal to 4 for research AUDIT-C is based on prior work demonstrating that sensitivity and specificity of unhealthy alcohol use is maximized for men at this cutoff (Babor et al., 1989; Bradley et al., 2003, 2007; Bush et al., 1998). For the purpose of calculating sensitivity and specificity (two types of agreement), we use research AUDIT-C 4+ as the reference group because, as mentioned previously, we believe it is subject to less social desirability bias and data collection errors than EMR AUDIT-C. We calculated kappa statistics for the overall sample and separately by HIV status. The kappa statistic measures agreement beyond that expected by chance alone and ranges from 0 to 1, with 1 representing perfect agreement. Landis and Koch suggest interpreting intermediate values as follows: 00. – poor; .00 to .20 – slight; .21 to .40 – fair; . 41 to .60 – moderate, .61 to .80 – substantial, and .81 to 1.00 – almost perfect (Landis and Koch, 1977).

We calculated kappa statistics, percent agreement, sensitivity, and specificity in subgroups by age, race/ethnicity, site, HCV, and alcohol related diagnosis. Kappa statistics were compared by HIV status and gender; and for men by age, race/ethnicity, site, hepatitis C status, and alcohol related diagnosis. As a sensitivity analysis, overall kappa statistics were also generated allowing for only 60 and 30 days between EMR and research AUDIT-C. Z-tests were used to determine whether kappa statistics were statistically significantly different between groups.

Because the recommended AUDIT-C cutoff for unhealthy drinking for women is 3+ (vs. 4+ for men) (Bradley et al., 2003; Bradley et al., 2007), we compared EMR AUDIT-C cutoffs of 2+ and 3+ to research AUDIT-C 3+ for women. The sample size for women is much smaller than for men so we did not compare agreement between subgroups for women. Analyses were run using Stata 13.0.

3. RESULTS

Of the 7,515 individuals (3,629 HIV+ and 3,501 uninfected men; and 99 HIV+ and 286 uninfected women) who completed a survey for VACS Baseline 2002 from June, 2002 to September, 2012, 6,766 were alive as of October, 2007 and 5,491 had a baseline or follow-up survey between October, 2007 and September, 2012. Of those, 5,179 (94%) had a non-missing research AUDIT-C value on their first VACS survey within the time frame, and

5,344 (97%) had at least one EMR AUDIT-C. Of those, 2,242 men (1,082 HIV+ and 1,160 uninfected), and 147 women (32 HIV+ and 115 uninfected) had an EMR AUDIT-C within 90 days before or after the research AUDIT-C.

3.1 HIV+ and Uninfected Men

The mean age at the time of the VACS survey was 53 years for HIV+ and 56 years for uninfected men. Of the HIV+ and uninfected men, respectively, 68% and 65% were African-American, 20% and 23% were white, and 12% and 12% were of Hispanic or other race/ethnicity. For HIV+ and uninfected men, fewer had an EMR AUDIT-C 4+ (14% and 15%) than a research AUDIT-C 4+ (21% and 23%) and more had an EMR AUDIT-C of zero (45% and 53%) than a research AUDIT-C of zero (39% and 45%) (Table 1).

Table 2 shows agreement of EMR AUDIT-C (cutoffs of 4+, 3+ and 2+) with research AUDIT-C (4+). For both HIV+ and uninfected men, using research AUDIT-C 4+ as the reference group, EMR AUDIT-C 2+ had the highest sensitivity, indicating that of those with research AUDIT-C 4+, 74% and 71% had EMR AUDIT-C of 2+. EMR AUDIT-C 3+ had sensitivity of 59% and 59%, and EMR AUDIT-C 4+ the lowest sensitivity (42% and 47%). Conversely, EMR AUDIT-C 4+ had the highest specificity, indicating that of those with research AUDIT-C<4, 94% and 95% of HIV+ and uninfected men also had an EMR AUDIT-C of <4. EMR AUDIT-C 3+ had specificity of 88% and 90%, and EMR AUDIT-C 2+ had the lowest specificity (78% and 82%). Based on kappa statistics, EMR AUDIT-C 3+ had better overall agreement than EMR 2+ and EMR 4+ for both HIV+ and uninfected men (kappa = 0.47 and 0.51 vs. 0.42 and 0.47; and 0.41 and 0.48; all $p<.05$) (Table 2).

To evaluate agreement within subgroups we compared EMR AUDIT-C 3+ cutoff to research AUDIT-C 4+. Agreement was moderate (kappa >0.40) for all subgroups examined except site 2. Overall agreement, based on kappa statistics, was statistically significantly higher for: men compared to women; and among men: HIV uninfected compared to HIV+, those ages 50–64 and 65+ compared to those <50, white compared to African-American, Hispanic, and other race/ethnicity, sites 1, 4 and 8 compared to other sites, HCV uninfected vs. HCV+, and those without an alcohol related diagnosis compare to those with (Table 3). Kappa statistics were statistically significantly different between all age groups except 50–64 and 65+; all racial/ethnic groups; all sites; and by HCV status and alcohol related diagnosis (yes/no).

Compared to using the 90 day window, kappa statistics were similar for 60 and 30 day windows (kappa = 0.49, n = 2,242 for the 90 day window; kappa = 0.49, n = 1,694 for the 60 day window; and kappa = 0.51, n = 1,127 for the 30 day window).

3.2 HIV+ and Uninfected Women

The mean age at the time of the VACS survey was 49 years for HIV+ and 50 years for uninfected women. Race/ethnicity was similar by HIV status; overall 72% were African-American, 17% were white, and 11% were of Hispanic or other race/ethnicity. For HIV+ and uninfected women, 9% and 9% had an EMR AUDIT-C 3+ and 16% and 13% had a research AUDIT-C of 3+. EMR AUDIT-C 2+ had higher sensitivity than EMR AUDIT-C 3+ for both HIV+ and uninfected women (60% and 67% vs. 40% and 40%). However, EMR

AUDIT-C 3+ had higher specificity than AUDIT-C 2+ for both HIV+ and uninfected women (96% and 96% vs. 93% and 87%).

Overall agreement, based on kappa statistics, was higher for EMR AUDIT-C 2+ (kappa = 0.46) than for EMR AUDIT-C 3+ (kappa = 0.42), using research AUDIT-C 3+ as the reference group. Agreement of EMR AUDIT-C 2+ with research AUDIT-C 3+ was moderate for both HIV+ (kappa = 0.53) and uninfected women (kappa = 0.44), and the difference is statistically significant ($p<.05$). Overall agreement was better for men compared to women (kappa= 0.49 vs. 0.46, $p<.05$).

4. DISCUSSION

EMR AUDIT-C identifies a lower percent with unhealthy alcohol use compared to the same cutoff for research AUDIT-C for both HIV+ and uninfected men and women. Using a lower threshold for EMR AUDIT-C (3+ for men; 2+ for women vs. 4+ for men; 3+ for women) identifies a higher percent with potentially unhealthy alcohol use and results in better agreement with research AUDIT-C (4+ for men; 3+ for women). This pattern is consistent for all subgroups examined and agreement between EMR AUDIT-C and research AUDIT-C was moderate for almost all subgroups compared.

Finding a lower percent with a positive AUDIT-C screen using EMR compared to research AUDIT-C is consistent with prior research. Three studies that compared VA EMR AUDIT-C to AUDIT-C from a mailed survey reported that the percent with a positive screen was lower for EMR compared to the mailed survey data (Bradley et al., 2011; Hawkins et al., 2007; Lapham et al., 2013). This finding is also consistent with a study on the effects of mode of question administration which found that disclosure of sensitive information was lower with face to face administration compared to paper administration (Bowling, 2005).

To put these findings in the context of prior studies, sensitivity reflects agreement/concordance of EMR AUDIT-C with a positive research AUDIT-C and specificity reflects agreement/concordance of EMR AUDIT-C with a negative research AUDIT-C. Our overall finding in men of 59% sensitivity and 89% specificity is similar to findings in other studies of 61% sensitivity and 93% specificity using AUDIT-C 4+ cutoffs (Hawkins et al., 2007) and 39% sensitivity and 99% specificity using AUDIT-C 5+ cutoffs (Bradley et al., 2011). Finding that sensitivity is lower in African-American and Hispanic men compared to white men and for certain sites is consistent with Bradley's research which also found that agreement was worse for African-Americans and for certain VHA networks (Bradley et al., 2011). Another VHA study by Lapham et al (2013) examined agreement between EMR and survey AUDIT-C using cutoffs of 4+ for men and 3+ for women among patients with 1 to 4 prior negative screens. Prevalence of positive AUDIT-C was lower for EMR than for survey screening, and sensitivity was low and decreased from 40.6% to 17.4% as the number of prior negative screens increased from 1 to 4. The EMR screen performed similarly for women and men, but performed better for older (≥ 65 years) compared to younger (< 50 years) patients in this study by Lapham et al. (2013).

That EMR AUDIT-C 3+ had better agreement with research AUDIT-C 4+ than EMR AUDITC 4+ suggests that using a cutoff of 3 may optimize sensitivity and specificity for identifying both HIV+ and uninfected men with unhealthy alcohol use when using the current VHA EMR data. Although other studies have compared EMR AUDIT-C to survey or research AUDIT-C, no other studies have made the comparisons in an HIV+ population, and none have identified lower cut-points that may more accurately identify patients with unhealthy alcohol use based on EMR screening. Identifying HIV+ individuals with unhealthy alcohol use provides an opportunity to provide alcohol interventions which, in addition to improving drinking outcomes, may ultimately improve adherence, overall health and mortality risk, and also reduce the risk of HIV transmission (Samet, et al., 2010; Parsons et al, 2007a; Chander et al., 2015; Hasin et al., 2013). Having more accurate assessments of unhealthy alcohol use could also be important for alerting providers to monitor more closely for alcohol related liver injury and drug interactions. Because alcohol impacts those with HIV at lower levels of use than among uninfected, it may be especially important to use a lower cutoff of AUDIT-C among HIV+.

We recommend that the EMR AUDIT-C screening be improved in order to reduce administration error and social desirability bias. Consistent with recommendations by Williams et al (2015), use of patient-administered screening tools, such as laminate, paper-based, or web-based tools, may address some of the current limitations of clinical screening.

There are several strengths of this analysis. We used data from the VHA, which benefits from one of the most highly-developed health information systems in the world (Corrigan et al., 2003; McQueen et al., 2004). The sample is demographically diverse, comprises multiple sites, and did not require substantial data resources or any additional participant burden. Compared to prior studies that used data on predominantly white populations in 2003–2004, 2006–2008, and 2007–2008, the VACS study population is comprised predominantly of minorities and uses AUDIT-C collected from 2007 to 2012.

There are several limitations to this study. Only 6% of the sample is women so we were underpowered to run analyses on subgroups for women, and due to the small number of HIV + women in this study, caution is warranted when interpreting the results for women. Both methods of identifying unhealthy alcohol use are based on a 3-item screen for unhealthy alcohol use (the AUDIT-C), as opposed to an in-depth assessment. While the AUDIT-C has been validated with high sensitivity and specificity for identifying unhealthy alcohol use and accounts for under-reporting (Bradley et al., 2003; Bush et al., 1998; Bradley et al., 2007; Frank et al., 2008), some mis-categorization is expected by design. However, similar to the validation studies, the research AUDIT-C questions and response options are fixed whereas there is variation in the way EMR AUDIT-C questions and response options are administered in the VHA, as noted previously (Williams et al., 2015). Although the demographics of the HIV+ and uninfected groups are similar, some differences exist (e.g., differential representation of women) and the demographic make-up of these groups may have influenced results. Similarly, it is unknown how alcohol use in this sample that includes 8 VHA sites compares to that of the general population of VHA outpatients. While patterns of any and unhealthy alcohol use have not been directly compared between the VACS matched sample and general VHA outpatients, survey AUDIT-C distributions from the

present study were similar to those reported in a previous study among a national sample of VHA outpatients (Williams et al., 2015).

Despite limitations of EMR AUDIT-C, EMR data hold the potential to help clinicians and researchers identify unhealthy alcohol use overall and in HIV+ and other subgroups. For example, these data provide the opportunity to generate large cohorts of patients who consume alcohol, evaluate health outcomes by AUDIT-C levels, track change in alcohol use over time, enroll patients into alcohol intervention programs, assess the impact of alcohol use interventions, and measure performance for quality improvement initiatives. EMR data can be retrieved efficiently, longitudinally, at low cost, and in a comprehensive cohort of patients. In addition, this methodology for using EMR data can serve as a useful model for other healthcare organizations as they use or transition to EMRs. Findings from this study add to previous literature suggesting limitations regarding the quality of clinical alcohol screening administered in this large healthcare system and help identify cut-points that maximize identification of unhealthy alcohol use in these populations given the current limitations of clinically-administered screening. Researchers and clinicians using AUDIT-C from EMRs should consider replicating this work, particularly in a sample containing a greater number of women, to determine optimal EMR AUDIT-C cutoffs relevant to their research or clinical purposes and taking into consideration the type of mode and administration of the AUDIT-C being used.

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List of Abbreviations

VACS	Veteran Aging Cohort Study
HIV+	HIV Infected
AUDIT-C	Alcohol Use Disorder Identification Test- Consumption
HCV	Hepatitis C Virus
Alc Rel Dx	alcohol related International Classification of Diseases, Ninth Revision diagnosis
EMR	Electronic Medical Record

Highlights

- Electronic medical record (EMR) AUDIT-C under represents alcohol consumption
- EMR-based AUDIT-C may warrant lower thresholds
- Strategies to improve the quality of EMR-based AUDIT-C should be pursued

Table 1

Characteristics of Male Participants with EMR and VACS Research AUDIT-C

	HIV+	Uninfected	P-Value
N	1,082	1,160	
Mean Age, (SD)	53 (8.6)	56 (9.4)	**<.001**
Race/Ethnicity (%)			.3
White	20	23	
African American	68	65	
Hispanic/Other	12	12	
HCV	51	32	**<.001**
Site			
1	20	12	**<.001**
2	5	8	
3	15	15	
4	12	14	
5	13	19	
6	13	9	
7	18	21	
8	4	4	
Alcohol Related Dx	17	26	**<.001**
EMR AUDIT-C (%)			
0	45	53	**<.001**
1–2	34	26	
3	8	6	
4+	14	15	
Research AUDIT-C (%)			
0	39	45	**.001**
1–2	30	24	
3	10	9	
4+	21	23	

EMR, electronic medical record; SD, standard deviation

Table 2

Comparison of EMR and Research AUDIT-C Screening Results in Men

	HIV+			Uninfected		
	Research			Research		
	AUDIT-C 4+	**AUDIT-C <4**	**N**	**AUDIT-C 4+**	**AUDIT-C <4**	**N**
EMR	(n=225)	(n=857)		(n=266)	(n=894)	
AUDIT-C 4+	**95 (42%)**	55 (6%)	150	**126 (47%)**	45 (5%)	171
AUDIT-C <4	130 (58%)	**802 (94%)**	931	140 (52%)	**849 (95%)**	989
Kappa	0.41			0.48		
EMR						
AUDIT-C 3+	**133 (59%)**	100 (12%)	233	**157 (59%)**	85 (10%)	242
AUDIT-C <3	92 (41%)	**757 (88%)**	848	109 (41%)	**809 (90%)**	918
Kappa	0.47			0.51		
EMR						
AUDIT-C 2+	**166 (74%)**	192 (22%)	357	**189 (71%)**	164 (18%)	353
AUDIT-C <2	59 (26%)	**665 (78%)**	724	77 (29%)	**730 (82%)**	807
Kappa	0.42			0.47		

Bold numbers represent agreement. All percentages are column percents

Table 3

Unhealthy Alcohol Use in Men in the Veterans Aging Cohort Study (VACS), by Demographics and Characteristics, Based on VACS Research Survey and Electronic Medical Record AUDIT-C

		N	Research AUDIT-C 4+ (%)	EMR AUDIT-C 3+ (%)	Agreement (%)	Sensitivity* (%)	Specificity* (%)	Kappa
All		2242	21.9	21.2	82.8	59.1	89.4	0.49
HIV+	Yes	1082	20.8	21.5	82.2	59.1	88.3	0.47
	No	1160	22.3	20.9	83.3	59.0	90.5	0.51
Age	<50	602	25.7	24.8	79.1	57.4	86.6	0.45
	50–64	1394	21.9	20.8	83.4	59.7	90.1	0.51
	65+	246	12.6	14.6	88.2	61.3	92.1	0.50
Race/ Ethnicity	White	485	20.6	17.5	87.0	61.0	93.8	0.58
	African-Amerian	1489	21.6	22.1	81.9	59.2	88.1	0.49
	Hispanic	185	29.7	23.8	77.8	52.7	88.5	0.44
	Other	83	18.1	20.5	85.5	66.7	89.7	0.54
Site	1	351	19.4	19.9	86.9	67.7	91.5	0.59
	2	142	27.5	24.6	76.1	51.3	85.4	0.38
	3	331	22.1	17.2	81.3	46.6	91.1	0.41
	4	293	25.3	23.9	83.6	64.9	90.0	0.56
	5	360	23.3	20.8	81.9	56.0	90.0	0.48
	6	244	17.2	23.8	81.1	64.3	854.	0.42
	7	439	20.7	20.7	83.1	59.3	89.4	0.49
	8	82	24.4	23.2	86.6	70.0	91.9	0.63
HCV	Yes	921	22.3	21.1	81.6	56.1	89.0	0.46
	No	1321	21.7	22.3	83.6	61.2	89.9	0.51
Alcohol	Yes	487	32.4	33.1	76.3	64.6	82.0	0.46
Related Dx	No	1755	19.0	17.9	84.6	56.5	91.1	0.49

*Sensitivity and Specificity assume that research AUDIT-C is the reference group; sensitivity represents concordance of EMR AUDIT-C with positive research AUDIT-C; specificity represents concordance of EMR AUDIT-C with negative research AUDIT-C.