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The use of administrative data as a substitute for individual screening scores in observational studies related to problematic alcohol or drug use

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ABSTRACT

Administrative data provide a rich resource for improving our understanding of individuals with substance use disorders. The validation of administrative proxies for moderate or high risk alcohol or drug (AOD) use could enhance the ability to carry out rigorous observational research (for example, for use in the construction of comparison groups). This study used receiver operating characteristic (ROC) curve techniques to assess how well AOD-related administrative indicators predicted self-reported AOD use obtained from AUDIT/DAST screening scores. An administrative AOD indicator, derived from a combination of medical encounter and billing data, arrest records, and publicly funded AOD-related services data, demonstrated discrimination in the acceptable range (AUC: 0.72–0.78) for identifying self-reported AOD use consistent with potential need for either (1) any AOD-related intervention, or (2) intensive AOD-related intervention or treatment. These findings held up in two distinct samples: a statewide Medicaid-only sample and a single-site mixed-payer sample that included the uninsured. Our findings suggest that indicators of AOD-related problems derived from administrative data can be useful for identifying moderate or high risk AOD use in a research context. The findings further suggest that proxies for substance use disorders, such as those evaluated here, can enhance future observational studies intended to improve health care for this population.

1. Introduction

Administrative data provide a rich resource for improving our understanding of individuals with substance use disorders. These individuals have a high rate of disability and premature death, are at high risk for treatment non-adherence, and use a disproportionate amount of health care resources, yet are often excluded from traditional clinical trials (Institute of Medicine, 2000; Justice et al., 2006; Mancuso et al., 2007; Mancuso et al., 2004; Walkup and Yanos, 2005). Observational studies and analyses of administrative data provide an important means of expanding the sparse knowledge about this population (Justice et al., 2006; Walkup and Yanos, 2005).

The validation of proxies for substance use disorders could enhance the ability to carry out rigorous observational research (for example, for use in the construction of comparison groups) which, in turn, could offer increased potential to improve health care for this population. Information in administrative records such as alcohol or drug (AOD)-related diagnoses (e.g., alcohol or drug psychoses, alcohol or drug dependence), receipt of detoxification services, chemical dependency treatment, and/or evidence of AOD-related arrests (e.g., driving while intoxicated) have been used as proxies for substance use disorders or need for AOD treatment in a number of observational studies (Estee and Nordlund, 2001, 2003; Gerson et al., 2001; Kohlenberg et al., 1999; Luchansky et al., 2006; Wickizer et al., 2006). While these measures have reasonable face validity, to our knowledge, they have not yet been rigorously validated.

We therefore designed this study to assess the validity of using administrative proxies for AOD-related problems in observational research. We used scores from two widely accepted screening instruments, the Alcohol Use Disorders Identification Test (AUDIT)

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and the Drug Abuse Screening Test (DAST) (Babor and Kadden, 2005). We also used data from three administrative sources: electronic medical encounter and billing records (e.g., diagnoses, procedures), publicly funded AOD-related service records (receipt of detoxification/chemical dependency treatment services), and arrest records (i.e., AOD-related arrests). These data were obtained as part of a study among a general emergency department (ED) population (see Section 2.1).

The availability of both screening data and administrative data for the same population presented the unusual opportunity to assess the extent to which administrative indicators of AOD-related problems could be used in research analyses as a substitute for self-reported problematic AOD use as measured by the AUDIT and DAST. It also allowed assessment of how the discriminatory performance of administrative AOD indicators might vary for two different cutpoints on the AUDIT/DAST: one suggesting potential need for some intervention, and the other suggesting potential need for intensive intervention or treatment. (The AUDIT/DAST cutpoints were selected based on published intervention guidelines, described in detail in Section 2.4.) Finally, it made possible the examination of the relative importance of the three administrative data sources (individually and in various combinations) in identifying problematic AOD use. We also had the opportunity to conduct these analyses in two different samples in order to assess the robustness of our findings: a statewide Medicaid-only sample and a single-site mixed-payer sample that included the uninsured. Our analyses address the following three research questions:

(1) How well do indicators of AOD-related problems found in administrative data sources identify self-reported AOD use patterns that indicate potential need for *any* AOD-related intervention?
(2) How well do indicators of AOD-related problems found in administrative data sources identify self-reported AOD use patterns that indicate potential need for *intensive* AOD-related intervention?
(3) Are the three administrative data sources available to us (i.e., medical encounter and billing data, publicly funded AOD-related services, arrest records) equally useful and interchangeable for predicting the results of AUDIT/DAST screening? Or is it important to include all or some specific subset of these data sources when developing an AOD indicator?

2. Methods

2.1. Setting

The data used in this study were collected as part of the Washington State Screening, Brief Intervention, and Referral to Treatment (WASBIRT) Program and its evaluation. The program hired chemical dependency professionals in nine hospital EDs throughout the state to screen patients for alcohol and drug use. Brief interventions (BIs) and referrals to brief treatment (BT) or chemical dependency treatment were provided when indicated. Patients were screened using two standardized AOD screening instruments: the ten-item Alcohol Use Disorders Identification Test (AUDIT, available online at: http://whqlibdoc.who.int/hq/2001/WHO_MSD_MSB_01.6a.pdf) and the ten-item version of the Drug Abuse Screening Test (DAST-10, available online at: http://www.chammp.org/Training/Assessment-Tools/Substance-Use.aspx).

As of December 31, 2008, the Harborview Medical Center (HMC) site had performed approximately 17% of the more than 106,000 screenings conducted by WASBIRT. HMC is a comprehensive healthcare facility located in Seattle, Washington. HMC is owned by King County and managed by the University of Washington (UW). It is a primary teaching site for the UW School of Medicine and other UW Health Sciences programs. HMC's mission includes serving low-income uninsured patients, and those with mental health and substance use problems. The other eight participating hospitals ranged from a small hospital in a rural community to large hospitals in major metropolitan areas in the state.

WASBIRT was funded by the federal Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Substance Abuse Treatment, in an award to the Washington State Division of Alcohol and Substance Abuse (DASA) in 2003. The Center for Healthcare Improvement for Addictions, Mental Illness and Medically Vulnerable Populations (CHAMMP) at HMC was commissioned by DASA to carry out an evaluation of patient outcomes at the HMC site as a complement to the statewide evaluation of WASBIRT being carried out by the Division of Research and Data Analysis (RDA) of the Washington State Department of Social and Health Services (DSHS).

Table 1
Key to alcohol or drug (AOD) indicators.

Indicator	Data source
AOD_M	AOD-related diagnoses or services identified in encounter and billing data from Medicaid or Harborview Medical Center, depending on sample (based on ICD-9 diagnoses, ICD-9 procedure codes, DRG codes, CPT codes, and hospital service centers)
AOD_T	TARGET: receipt of publicly funded AOD-related services in Washington State
AOD_W	Washington State Patrol: felony and gross misdemeanor arrests for AOD-related offenses
AOD_{MT}	Set to 1 if AOD_M or $AOD_T = 1$; set to 0 otherwise
AOD_{MW}	Set to 1 if AOD_M or $AOD_W = 1$; set to 0 otherwise
AOD_{TW}	Set to 1 if AOD_T or $AOD_W = 1$; set to 0 otherwise
AOD_{MTW}	Set to 1 if AOD_M or AOD_T or $AOD_W = 1$; set to 0 otherwise

2.2. Sample

We used two distinct samples for the study presented here: a statewide sample and an HMC sample. The statewide sample included 10,721 patients enrolled in Medicaid or a state-funded Medical Care Services program due to disability incapacity criteria. These patients were screened by WASBIRT between April 2004 and December 2008 and had fee-for-service medical coverage through Medicaid or the state program in the month in which WASBIRT screening occurred or in at least one of the 12 prior months. The statewide sample excluded individuals who were "dually eligible" for Medicaid and Medicare at any point in the study period or who only had Medicare coverage, since we did not have access to Medicare-paid claims data. The statewide sample also excluded patients who were covered by a managed care plan through Medicaid, uninsured patients, and patients with private medical insurance. The HMC sample included 6702 patients who were screened by WASBIRT in the HMC ED between April 2004 and November 2006. Nearly half of this sample was uninsured, and a wide variety of payers were represented, including Medicaid, Medicare, public or private insurance, and workers' compensation. The HMC sample excluded patients over 65 and those who were known to reside outside Washington State at the time of screening.

To be screened by WASBIRT and included in either sample, patients had to be at least 18 years of age and not in custody. Screening was limited to English-speaking patients at some sites, including HMC, but could include Spanish-speaking patients at sites with the capacity to conduct WASBIRT services in Spanish. Due to case selection criteria used to construct the intervention and comparison groups for the evaluation of WASBIRT at HMC, 130 patients were excluded from the HMC sample based on screening visits that were related to sexual assault, involved transfers from another institution, or resulted in death, discharge to another institution or a hospitalization of 30 days or more.

2.3. Data sources and administrative AOD indicators

Data from three sources (medical encounter and billing records, arrests, publicly funded AOD-related services) were used to identify administrative indicators of AOD-related problems in the year prior to and including the WASBIRT AUDIT/DAST screening (AUDIT and DAST questions also cover the same 1-year period). Patient identifiers were linked to WASBIRT participant identifiers and subsequently linked to each administrative database using the Link King, a public domain program for deterministic and probabilistic linkage of administrative records. In a validation study using reviewers' decisions as the gold standard, the Link King produced linkages with a positive predictive value of 97% and a sensitivity of 96%. In contrast, a basic deterministic algorithm achieved the same positive predictive value but a sensitivity of only 79%, thereby failing to link many records (Campbell et al., 2008).

For each sample, we constructed three administrative AOD indicators specific to each of the three administrative data sources (as described below) and then combined these indicators in various ways, resulting in the set of seven indicators described in Table 1. (Note that these indicators have some overlap; e.g., both the medical indicator and the AOD-related service indicator may have been set by a sin-

gle publicly funded health care visit at which AOD-related services were provided.) In developing these indicators, we followed conventions developed by RDA. Lists of the specific codes used to trigger the AOD indicators for each data source are in the public domain (Estee and Nordlund, 2001, 2003; Lucenko et al., 2008). We made some adjustments due to differences in data structure between the statewide and HMC analyses and changes in coding dictionaries and practices over time. (Lists of codes used for this project are available from the first author, but the choice of any specific set of codes will be setting and time-dependent.)

2.3.1. AOD indicator based on medical encounter and billing data. For the statewide sample, the medical AOD indicator (AOD_M) was based on data from the DSHS Medicaid Management Information System (MMIS), which includes medical claims and encounter data. In particular, this indicator was based on data from inpatient and outpatient admissions, as well as non-hospital-based medical care (e.g., clinic visits) in the 12 months prior to and including the screening visit. It was set to 1 in the presence of (1) an ICD-9 diagnosis code indicating AOD abuse or dependence, alcoholic liver damage, and/or counseling on substance use and abuse, (2) ICD-9 procedure codes for AOD detoxification, (3) Diagnosis-Related Group (DRG) codes indicating AOD abuse or dependence, (4) Current Procedural Terminology (CPT) and Healthcare Common Procedure Coding System (HCPCS) codes indicating AOD-related counseling services, (5) revenue codes (e.g., detoxification room and board stays), and (6) filled prescriptions for drugs commonly used to treat substance abuse.

For the HMC sample, the medical AOD indicator (AOD_M) was based on encounter and billing data and professionally coded discharge diagnoses for the 12 months prior to and including the AUDIT/DAST screening. We based our indicators on RDA's previous work, but needed to make adjustments due to the ways in which HMC data differed from Medicaid data (e.g., some diagnostic and procedure codes were found only in Medicaid data and others were found only in HMC data). The HMC-based AOD_M indicator was based on HMC data for inpatient and outpatient admissions in the 12 months prior to and including the screening visit. It was set to 1 in the presence of (1) an ICD-9 diagnosis code indicating AOD abuse or dependence, alcoholic liver damage, and/or counseling on substance use and abuse, (2) ICD-9 procedure codes for AOD detoxification, (3) DRG codes indicating AOD abuse or dependence, (4) CPT codes indicating AOD-related counseling services, and/or (5) any services received in HMC's Addictions Clinic.

2.3.2. AOD indicator based on the Treatment and Report Generation Tool (TARGET) data. Data regarding receipt of publicly funded AOD-related services were obtained from the Treatment and Report Generation Tool (TARGET). TARGET is an administrative reporting system of the Washington State Division of Alcohol and Substance Abuse (DASA). TARGET contains service records for all individuals who received publicly funded assessment, detoxification, or chemical dependency treatment services. Low-income Washington State residents may be eligible for publicly funded treatment services if they are assessed as alcohol or drug dependent by a state-certified chemical treatment agency.

The TARGET-based AOD indicator (AOD_T) was set to 1 if admission to or receipt of AOD-related services was recorded in the TARGET database during the 12 months prior and including the WASBIRT screening visit. AOD-related services include chemical dependency treatment, transitional housing, or detoxification services.

2.3.3. AOD indicator based on Washington State Patrol (WSP) data. Data for arrests in Washington State were obtained from the Washington State Patrol (WSP). The WSP-based AOD indicator (AOD_W) was set to 1 if any arrest for an AOD-related offense during the 12 months prior to and including the screening visit was recorded in the WSP database.

2.4. Data analysis

Discriminatory performance of the AOD indicators was assessed using receiver operating characteristic (ROC) curve techniques, specifically the area under the curve (AUC). This measure has the advantage of summarizing sensitivity and specificity into a single number, and is useful when it is desirable to weight sensitivity and specificity equally (Greiner et al., 2000). We also report sensitivity and specificity estimates, as there are settings where maximizing one or the other is useful. For example, if one wished to identify a select group of high-risk individuals, maximizing specificity might be more important. In this study, sensitivity represents the percent of those with a particular administrative indicator present and a high AUDIT/DAST score (true positives) out of all those with high AUDIT/DAST scores. Specificity represents the percent of those with the absence of a particular administrative indicator and a low AUDIT/DAST score (true negatives) out of all those with low AUDIT/DAST scores. We do not report positive and negative predictive values (PPV and NPV), as these measures vary with prevalence and our samples had a relatively high prevalence of AOD-related problems (Mandic et al., 2008).

AUDIT/DAST screening scores were used as the validation standard for assigning the level of AOD use and need for intervention or treatment. The AUDIT and DAST were developed as screening tools, rather than as substitutes for full diagnostic assessment interviews or clinical diagnosis. However, these screening measures have been validated with diagnostic measures for substance abuse and dependence (e.g., current hazardous or harmful use and lifetime dependence) that are considered the gold standard in the field (Allen et al., 1997; Maisto et al., 2000; Saunders et al., 1993; Yudko et al., 2007). For purposes of the ROC techniques we employ, the screening scores serve as the "gold standard" and summarize self-reported patterns of AOD use to indicate potential need for certain levels of intervention. The AUDIT/DAST scores do not indicate the presence of a diagnostic entity nor a definite need for a specific level of intervention. Because AUDIT/DAST scores are screening tools with expected error in the form of false negatives and false positives, ROC techniques will likely be conservative in measuring the estimated accuracy of the administrative AOD indicators (Leeflang et al., 2009).

We used two cutpoints to examine whether the administrative indicators performed differently in identifying different levels of AOD use. There has been much discussion in the literature as to which AUDIT cutpoints should best be used to detect hazardous drinking and potential need for intervention or treatment (Reinert and Allen, 2007). We based our cutpoints on the intervention recommendations in the AUDIT (Babor et al., 2001) and DAST (Skinner, 1982) manuals. To address research question 1, we used AUDIT and DAST scores to create a binary gold standard by dividing each sample into those with versus those without a potential need for *any* AOD-related intervention (low or high intensity). We used a score of 8 on the AUDIT (corresponding to the transition in recommended intervention from "alcohol education" suggested for all to "simple advice"), or a score of 1 on the DAST (corresponding to the transition in suggested intervention from "monitor" suggested for all to "brief counseling"). For research question 2, we constructed a binary gold standard by dividing each sample into those with versus those without potential need for *intensive* AOD-related intervention or treatment. We used a score of 20 on the AUDIT (corresponding to "referral to specialist for diagnostic evaluation and treatment") or a score of 6 on the DAST (corresponding to "intensive" intervention). For both research questions, a qualifying score on either the AUDIT or DAST moved an individual into the relevant category.

For the HMC sample, sensitivity, specificity, nonparametric AUC, and 95% confidence intervals for AUC were estimated for each AOD indicator using the Stata command – roctab – with the default variance estimation method (described by Cleves, 2002). For the statewide sample, we used the logistic regression procedure (Proc Logistic) in SAS to fit a series of logistic regression models that allowed us to generate the same statistics (SAS Institute, 2010). In particular, each AOD indicator was included in a separate model predicting the probability that an individual would be in the "any intervention" sample. A second set of models used the AOD indictors to predict the probability of being in the "intensive treatment" sample. Note that because these indicators are binary, the AUC estimate represents the lower bound (see van den Hout, 2003). To assess performance of the indicator variants, we independently compared each against the all-source AOD indicator (AOD_{MTW}) using the Stata command – rocgold – for the HMC sample. Following DeLong et al. (1988), we used the SAS ROC macro to make these same comparisons for the statewide sample. Both uncorrected and Bonferroni-corrected *p*-values were calculated for the test of whether a particular AOD indicator's AUC differed from that of the all-source AOD indicator in correlated samples.

To evaluate AUC, we used qualitative guidelines based on recommendations by Hosmer and Lemeshow (2000): (a) if AUC = .5, the test has no discrimination, (b) .5 < AUC < .7, poor discrimination, (c) .7 ≤ AUC < .8, acceptable discrimination, (d) .8 ≤ AUC < .9, excellent discrimination, and (e) AUC ≥ .9, outstanding discrimination.

Analyses for the statewide sample were performed at RDA using SAS 9.2 for Windows (SAS Institute, Cary, NC). Analyses for the HMC sample were performed at CHAMMP using Stata/IC 10.1 for Windows (StataCorp LP, College Station, TX). (The use of different statistical software was due to differing analyst preferences at the two sites.) The WASBIRT study protocol was reviewed and approved by the Washington State Institutional Review Board and three institutional review boards that oversee research within specific hospitals.

3. Results

3.1. Statewide sample

Of the 10,721 fee-for-service Medicaid patients screened statewide, 55.9% had AUDIT/DAST scores that indicated potential need for at least some AOD-related intervention and 32.7% had AUDIT/DAST scores that indicated potential need for intensive intervention or treatment.

Descriptive statistics for the statewide sample are presented in Table 2. In general, the subgroups defined by either "some intervention needed" or "intensive treatment needed" had a much higher prevalence of all AOD indicator variants. For example, the all-source indicator (AOD_{MTW}) was present for 71.6% of those above the "some intervention needed" cutpoint, but was present for only 27.6% of those below that cutpoint. As expected, this indicator was even more prevalent among those above the "intensive treatment needed" cutpoint (present for 83.2%), but was present for only 37.1% of those below that cutpoint.

Table 2
Statewide sample characteristics ($N = 10{,}721$).

Characteristic	Overall sample	AUDIT/DAST cutpoints = some intervention needed[a]		AUDIT/DAST cutpoints = intensive treatment needed[b]	
	($N = 10{,}721$)	No ($N = 4733$)	Yes ($N = 5988$)	No ($N = 7219$)	Yes ($N = 3502$)
Male (%)	56.3	44.2	65.8	51.8	65.6
Age: mean (SD)	39.8 (11.4)	41.2 (11.9)	38.7 (11.0)	40.4 (11.9)	38.7(10.4)
Age: median	41	43	40	42	40
Race/ethnicity (%)					
African-American/Black	14.2	11.7	16.1	14.4	13.6
Asian/Pacific Islander	0.9	1.1	0.7	1.0	0.5
Latino/Hispanic	6.9	8.6	5.6	7.6	5.6
Native American	5.9	4.8	6.9	4.9	8.1
White	70.8	72.4	69.6	70.5	71.4
Unknown	0.4	0.5	0.3	0.5	0.1
Other/multiple	0.9	1.0	0.9	1.0	0.8
County of service (% at screening ED visit)					
Clark	9.4	8.8	9.8	8.7	10.7
King	31.3	21.7	38.8	26.8	40.4
Pierce	16.3	21.0	12.5	19.9	8.9
Snohomish	15.4	15.4	15.4	15.2	15.8
Thurston	8.4	9.5	7.6	9.1	7.1
Yakima	19.3	23.4	16.0	20.3	17.1
AUDIT score: mean (SD)	8.8 (11.4)	1.6 (1.9)	14.4 (12.6)	3.5 (4.5)	19.6 (13.5)
AUDIT score: median	3	1	11	2	22
DAST score: mean (SD)	2.3 (3.2)	0 (0)	4.0 (3.4)	0.7 (1.4)	5.5 (3.5)
DAST score: median	0	0	4	0	7
AOD_M (% with indicator)	36.9	19.9	50.4	26.6	58.3
AOD_T (% with indicator)	30.8	12.6	45.3	17.2	58.9
AOD_W (% with indicator)	10.6	4.9	15.1	7.3	17.3
AOD_{MT} (% with indicator)	49.2	25.6	67.9	34.2	80.2
AOD_{MW} (% with indicator)	42.6	23.0	58.0	31.1	66.3
AOD_{TW} (% with indicator)	35.4	15.3	51.3	21.4	64.4
AOD_{MTW} (% with indicator)	52.2	27.6	71.6	37.1	83.2

Note: A qualifying score on either the AUDIT or DAST moved an individual into the relevant category. M: medical, T: TARGET, W: WSP/arrest; see Table 1 for definitions of each indicator.

[a] AUDIT ≥ 8 and/or DAST ≥ 1.

[b] AUDIT ≥ 20 and/or DAST ≥ 6.

Sensitivity, specificity and AUC are presented in Table 3 (using the "some intervention needed" cutpoint) and Table 4 (using the "intensive treatment needed" cutpoint). AUC for the all-source indicator (AOD_{MTW}) was in the acceptable range, at .720 using the "some intervention needed" cutpoint and .731 using the "intensive treatment needed" cutpoint. Using the "some intervention needed" cutpoint, both the sensitivity and specificity for AOD_{MTW} were 72%. Using the "intensive treatment needed" cutpoint, the sensitivity for AOD_{MTW} was 83% and the specificity was 63%. Using the "some intervention needed" cutpoint, all indicator variants were significantly inferior to AOD_{MTW} in terms of AUC, and only AOD_{MTW} and AOD_{MT} demonstrated acceptable discrimination. Using the

Table 3
Sensitivity, specificity, and AUC[a] for each AOD indicator using AUDIT/DAST cutpoints indicating need for *some intervention*[b].

AOD indicator	Sensitivity	Specificity	AUC	AUC 95% CI	*P*-Value for AUC comparison: each AOD indicator with AOD_{MTW} (H_0: $AOD_X = AOD_{MTW}$)	Adjusted *P*-value[c]
Statewide						
AOD_M	50%	80%	0.652	0.644–0.661	<.001	<.001
AOD_T	45%	87%	0.664	0.656–0.671	<.001	<.001
AOD_W	15%	95%	0.551	0.545–0.556	<.001	<.001
AOD_{MT}	68%	74%	0.711	0.703–0.720	<.001	<.001
AOD_{MW}	58%	77%	0.675	0.666–0.683	<.001	<.001
AOD_{TW}	51%	85%	0.680	0.672–0.688	<.001	<.001
AOD_{MTW}	72%	72%	0.720	0.711–0.728	Reference	Reference
HMC						
AOD_M	52%	89%	0.705	0.695–0.714	<.001	<.001
AOD_T	29%	93%	0.610	0.601–0.618	<.001	<.001
AOD_W	12%	97%	0.543	0.537–0.549	<.001	<.001
AOD_{MT}	60%	85%	0.723	0.713–0.734	.009	NS
AOD_{MW}	55%	87%	0.717	0.707–0.727	<.001	<.001
AOD_{TW}	34%	91%	0.628	0.618–0.637	<.001	<.001
AOD_{MTW}	62%	83%	0.728	0.718–0.738	Reference	Reference

Note: M: medical, T: TARGET, W: WSP/arrest; see Table 1 for definitions of each indicator.

[a] AUC = area under receiver operating characteristic (ROC) curve.

[b] AUDIT ≥ 8 and/or DAST ≥ 1.

[c] *P*-Value adjusted for multiple comparisons using Bonferroni correction.

Table 4
Sensitivity, specificity, and AUC[a] for each AOD indicator using AUDIT/DAST cutpoints indicating need for *intensive treatment*[b].

AOD indicator	Sensitivity	Specificity	AUC	AUC 95% CI	*P*-Value for AUC comparison: each AOD indicator with AOD_{MTW} (H_0: $AOD_X = AOD_{MTW}$)	Adjusted *P*-value[c]
Statewide						
AOD_M	58%	73%	0.659	0.649–0.668	<.001	<.001
AOD_T	59%	83%	0.708	0.699–0.717	<.001	<.001
AOD_W	17%	93%	0.550	0.543–0.557	<.001	<.001
AOD_{MT}	80%	66%	0.730	0.722–0.739	NS	NS
AOD_{MW}	66%	69%	0.676	0.667–0.685	<.001	<.001
AOD_{TW}	64%	79%	0.715	0.706–0.724	<.001	<.001
AOD_{MTW}	83%	63%	0.731	0.722–0.739	Reference	Reference
HMC						
AOD_M	71%	79%	0.748	0.736–0.759	<.001	<.001
AOD_T	45%	90%	0.675	0.664–0.687	<.001	<.001
AOD_W	16%	95%	0.552	0.543–0.560	<.001	<.001
AOD_{MT}	81%	74%	0.777	0.767–0.788	NS	NS
AOD_{MW}	76%	76%	0.760	0.749–0.771	<.001	<.001
AOD_{TW}	51%	87%	0.687	0.676–0.699	<.001	<.001
AOD_{MTW}	84%	72%	0.777	0.766–0.787	Reference	Reference

Note: M: medical, T: TARGET, W: WSP/arrest; see Table 1 for definitions of each indicator.
[a] AUC = area under receiver operating characteristic (ROC) curve.
[b] AUDIT ≥ 20 and/or DAST ≥ 6.
[c] *P*-Value adjusted for multiple comparisons using Bonferroni correction.

Table 5
HMC sample characteristics (*N* = 6702).

Characteristic	Overall sample	AUDIT/DAST cutpoints = some intervention needed[a]		AUDIT/DAST cutpoints = intensive treatment needed[b]	
	(*N* = 6702)	No (*N* = 2526)	Yes (*N* = 4176)	No (*N* = 4654)	Yes (*N* = 2048)
Male (%)	69.3	61.1	74.2	66.8	74.8
Age: mean (SD)	38.8 (11.6)	40.2 (12.2)	37.9 (11.1)	38.7 (12.1)	38.8 (10.3)
Age: median	39	41	38	39	40
Payer (% at screening ED visit)					
Unsponsored	45.3	40.7	48.0	44.3	47.5
Medicaid	28.5	24.4	31.1	25.3	35.9
Medicare	6.2	7.6	5.4	6.7	5.3
Medicare/Medicaid	3.0	3.6	2.7	3.3	2.5
Commercial	16.9	23.8	12.8	20.5	8.8
Race/ethnicity (%)					
African-American/Black	21.6	21.2	21.8	21.6	21.6
Asian/Pacific Islander	2.2	3.1	1.6	2.6	1.1
Latino/Hispanic	3.7	4.1	3.4	3.9	3.2
Native American	2.8	1.4	3.6	1.8	5.0
White	64.5	63.5	65.2	63.7	66.4
Unknown	5.2	6.7	4.4	6.4	2.6
Residence (% at screening ED visit)					
Seattle	73.8	70.0	75.7	72.6	76.7
King County (outside Seattle)	13.1	14.8	12.1	13.8	11.7
Washington State (outside King County)	13.0	15.3	11.7	13.6	11.7
AUDIT score: mean (SD)	9.4 (10.8)	2.1 (2.1)	13.8 (11.6)	4.6 (4.8)	20.2 (12.6)
AUDIT score: median	4	2	11	3	23
DAST score: mean (SD)	2.1 (3.0)	0 (0)	3.4 (3.1)	0.8 (1.4)	5.0 (3.5)
DAST score: median	0	0	2	0	6
AOD_M (% with indicator)	36.2	10.7	51.6	21.0	70.6
AOD_T (% with indicator)	20.5	6.9	28.8	9.8	44.8
AOD_W (% with indicator)	8.4	3.1	11.6	5.2	15.6
AOD_{MT} (% with indicator)	42.9	15.1	59.8	26.0	81.5
AOD_{MW} (% with indicator)	40.1	13.1	56.4	24.2	76.2
AOD_{TW} (% with indicator)	24.8	8.9	34.4	13.3	50.8
AOD_{MTW} (% with indicator)	45.2	16.8	62.4	28.3	83.6

Note: A qualifying score on either the AUDIT or DAST moved an individual into the relevant category. M: medical, T: TARGET, W: WSP/arrest; see Table 1 for definitions of each indicator.
[a] AUDIT ≥ 8 and/or DAST ≥ 1.
[b] AUDIT ≥ 20 and/or DAST ≥ 6.

"intensive treatment needed" cutpoint, all indicators that included publicly funded AOD-related services-based data (AOD_T, AOD_{TW}, AOD_{MT}, and AOD_{MTW}) demonstrated acceptable discrimination. AOD_{MT} was the only indicator variant not significantly inferior to AOD_{MTW} in terms of AUC (though the absolute differences were very small for all indicators that included publicly funded AOD-related services-based data).

3.2. HMC sample

Of the 6702 individuals screened at HMC, 62.3% had AUDIT/DAST scores that indicated potential need for at least some AOD-related intervention and 30.6% had AUDIT/DAST scores that indicated potential need for intensive intervention or treatment.

Descriptive statistics for the HMC sample are presented in Table 5. As for the statewide sample, the subgroups defined by either "some intervention needed" or "intensive treatment needed" had a much higher prevalence of all of the AOD indicator variants. For example, the all-source indicator (AOD_{MTW}) was present for 62.4% of those above the "some intervention needed" cutpoint, but was present for only 16.8% of those below that cutpoint. As expected, this indicator was even more prevalent among those above the "intensive treatment needed" cutpoint (present for 83.6%), but was present for only 28.3% of those below that cutpoint.

Sensitivity, specificity and AUC are presented in Table 3 (using the "some intervention needed" cutpoint) and Table 4 (using the "intensive treatment needed" cutpoint). Only indicators that included medical encounter/billing-based data demonstrated acceptable discrimination using either cutpoint. AUC for the all-source indicator (AOD_{MTW}) was in the acceptable range, at .728 using the "some intervention needed" cutpoint and .777 using the "intensive treatment needed" cutpoint. Using the "some intervention needed" cutpoint, the sensitivity for AOD_{MTW} was 62% and the specificity was 83%. Using the "intensive treatment needed" cutpoint, the sensitivity for AOD_{MTW} was 84% and the specificity was 72%. Using both cutpoints, all indicator variants were significantly inferior to AOD_{MTW} in terms of AUC, with the exception of AOD_{MT} (though the absolute differences were very small for all indicators that included medical encounter/billing-based data).

4. Discussion

4.1. Summary and implications

In this study, we evaluated the discriminative ability of administrative AOD indicators to identify problematic AOD use. We derived the indicators from medical encounter and billing data, arrest records, and publicly funded AOD-related services data in two samples: (1) a statewide Medicaid-only sample, and (2) a single-site mixed-payer sample that included the uninsured. We found that an AOD indicator based on all three administrative data sources (AOD_{MTW}) demonstrated acceptable discrimination in both samples, according to Hosmer and Lemeshow's guidelines (2000).

We evaluated these indicators using two AUDIT/DAST score cutpoints that identify different levels of problematic AOD use ("some intervention needed" and "intensive treatment needed"). Although there was some variation between samples in the discriminative ability of the various AOD indicators, the AOD_{MTW} indicator met the guideline for acceptable discrimination for both cutpoints in both samples. In addition, for all AOD indicators, and for both the statewide and HMC samples, discrimination was better, sensitivity was higher, and specificity was lower for the "intensive treatment needed" cutpoint. These results suggest that AOD indicators derived from administrative data are useful for identifying moderate risk AOD use, and are particularly well-suited to identify high risk AOD use.

We also examined whether the three administrative data sources were equally useful in predicting need for AOD-related intervention. In this respect, we found some variation across the statewide and HMC samples. However, in both the statewide and HMC samples, medical data and publicly funded AOD treatment records appeared more important than arrest records. Arrest records contributed relatively little to AUC, though including them made a significant (but small) contribution to the AUC for the "some intervention needed" cutpoint in the statewide sample. However, despite being quite insensitive, the AOD_W indicator exhibited very high specificity (93–97%) using either cutpoint in both samples. Therefore, we recommend the use of arrest data when available.

We used ROC curve techniques to evaluate the usefulness of the three data sources by collapsing the three original indicators into new binary indicators in various combinations. We did not maintain the indicators derived from different data sources as separate variables in logistic regression modeling because we were interested in comparing the information derived from different data sources without regard to prevalence-dependent thresholds or the effects of including different numbers of variables in competing logistic regression models. However, with regard to applied statistical models, maintaining the indicators derived from different data sources as separate variables rather than collapsing them into a single indicator is likely to improve model fit and explanatory power. Therefore we recommend that such an approach be considered when implementing the use of these or similar indicators in applied settings.

Administrative measures of AOD abuse severity derived from AOD-related treatment data have been validated among those with known AOD-related problems (e.g., McCamant et al., 2007). A number of studies have validated the use of medical billing codes and algorithms for case-finding for a variety of self-reported or clinically diagnosed medical conditions (e.g., Rector et al., 2004; Wilchesky et al., 2004). However, we did not identify any such studies addressing case-finding for AOD-related problems or diagnoses, except for those specific to pharmaceutical claims data in which prescription utilization provided the "gold standard" (e.g., Parente et al., 2004). We were unable to identify any studies that assessed the performance of administrative proxies for the presence of AOD-related problems in general health services data. We believe the results reported here provide a unique contribution to the existing literature.

The use of administrative AOD indicators provides important benefits for the conduct of health services research with populations that have historically been excluded from traditional clinical trials, such as those with evidence of substance use disorders alone or in combination with mental illness or chronic medical conditions. For example, the use of AOD indicators enables statistical control for risk associated with substance use disorders in observational studies of unscreened populations, or the efficient initial identification of subgroups for interventional research. These indicators also incorporate behavioral markers (such as AOD-related arrests) that are not necessarily captured by screening or diagnostic tools. Our findings suggest that proxies for substance use disorders derived from administrative data can be defensibly included in the design of observational studies, including the construction of comparison groups. This, in turn, can enhance research efforts to improve health care. Although our findings support the use of administrative AOD indicators for observational research related to substance use disorders, it is important to recognize that, based on the generally low sensitivities and borderline specificities observed in this study, it would be inappropriate to rely solely on any of these administrative indicators in clinical settings to determine treatment or intervention for any specific individual.

4.2. Strengths and limitations

Our findings were quite robust, given the many known limitations of administrative data. We conducted several sensitivity analyses that added strength to our study. First, to allay concerns that our findings might be sample-specific, we conducted analyses using two distinct samples: a statewide Medicaid-only sample and a single-site mixed-payer sample that included the uninsured. Findings were comparable for the combined AOD indicator (AOD_{MTW}) in both samples. However, some differences were observed for individual indicators. Most notably, the medical-only indicator (AOD_M) appeared to perform better in the HMC sample. We were able to attribute the AOD_M performance difference between the statewide and HMC samples to the relative fullness of the medical encounter and billing data available in the HMC sample. For example, while HMC records contained up to 27 diagnoses per visit, Medicaid medical records contained no more than 9 diagnoses. Similarly, while all CPT codes were available in the HMC records, Medicaid records contained no more than 7 CPT codes per visit.

Second, we conducted a sensitivity analysis to assess the effect of excluding data generated by the screening visit itself. We excluded data from all three sources (arrests, medical encounters, and TARGET services) for the entire calendar month of the screening visit using the statewide sample. We found only small differences in AUC that did not affect our conclusions.

We also conducted sensitivity analyses designed to explore whether certain particularities of the HMC sample might be problematic. In particular, we had some concern that the HMC analyses might be negatively impacted because TARGET only captures publicly funded AOD-related services and 17% of the HMC sample had commercial insurance. We did in fact observe better performance of the TARGET indicator in the statewide sample. However, although the AOD indicator based solely on TARGET data had a slightly lower AUC for the commercially insured than for others, excluding those with commercial insurance from the HMC sample did not substantively change the HMC findings (data not presented). We also had some concern that diagnosis and procedure codes resulting from medical care occurring in any other setting throughout the state would be absent from the HMC analyses, and could be important. However, we found that restricting our HMC analysis to just those individuals residing in Seattle (and thus more likely to rely on HMC for a higher proportion of their medical care) did not notably change the HMC findings, even for the AOD indicator based solely on HMC medical data (data not presented).

We believe the robustness of our findings across the varied analyses described above supports the generalizability of our conclusions about the usefulness of AOD indicators constructed from administrative data, even though the sensitivity, specificity, and AUC findings reported here are specific to Washington State. The use of data from other health care providers/insurers, other state data sources, or similar data sources in other states would have unknown impact on the performance of resultant AOD indicators. By definition, everyone in our samples had at least one ED visit. This group may have a relatively high prevalence or severity of AOD use, which has the potential to inflate sensitivity, specificity, and AUC estimates above what might be observed in other populations (Leeflang et al., 2009). The AUCs we observed would likely be smaller in community samples (samples that might include those with no health care visits). The AUDIT/DAST cutpoints we selected were somewhat arbitrary and ideal cutpoints will vary depending on the particulars of aims and setting. We encourage other researchers to validate these and similar administrative indicators in other populations using other cutpoints to add to our collective knowledge base.

5. Conclusions

There is a dearth of knowledge on how to effectively address the health care needs of individuals who have substance use disorders, either alone or in combination with mental illness or chronic medical conditions. Obtaining more knowledge is complicated by the challenges of including patients with complex health conditions in clinical trials or surveys. Medical records, treatment records, and other administrative records offer unique alternative data sources. Yet administrative records typically do not include self-reported measures of substance use.

In this study, we created several administrative indicators of alcohol or drug use and evaluated their discriminative ability to predict self-reported AOD use. We demonstrated that an administrative AOD indicator derived from a combination of medical encounter and billing data, arrest records, and publicly funded AOD-related services data exhibited acceptable discrimination (according to Hosmer and Lemeshow's guidelines, 2000) for the identification of either moderate risk or high risk AOD use in a research context. These results held up in two distinct samples: (1) a statewide Medicaid-only sample, and (2) a single-site mixed-payer sample that included the uninsured. Our findings suggest that administrative proxies for substance use disorders are suitable to enhance future research efforts focused on improving health care for patients with substance use disorders. The construction of comparison groups, estimation of health condition prevalence, identification of mutable moderators and mediators of health outcomes, and the identification and validation of intervention strategies could all benefit from the ability to use administrative records to identify moderate or high risk AOD use.

Conflict of interest

All authors are currently employees of either the University of Washington or the Washington State Department of Social and Health Services and have no conflicts of interest or financial interests.

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Contributors

Dr. Sears conceived and designed the analytic and statistical approach, took full responsibility for data management and execution of the single-site analyses, and wrote the first draft of the manuscript. Dr. Krupski contributed to the conception and design of the analysis, edited the manuscript, and made substantial contributions to the introduction and discussion. Dr. Joesch provided methodological and statistical support, and made substantial contributions to the design of the analysis, interpretation of the data, and revision of the manuscript. Dr. Estee contributed to the conception and design of the analysis, acquisition of data, and revision of the manuscript. Dr. He contributed to the acquisition of data and executed the statewide analyses. Dr. Roy-Byrne made substantial contributions to the introduction and revision of the manuscript. Ms. Ford Shah and Drs. Huber, Dunn, and Ries participated in the review and editing of the manuscript.

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