

Supplemental Online Content

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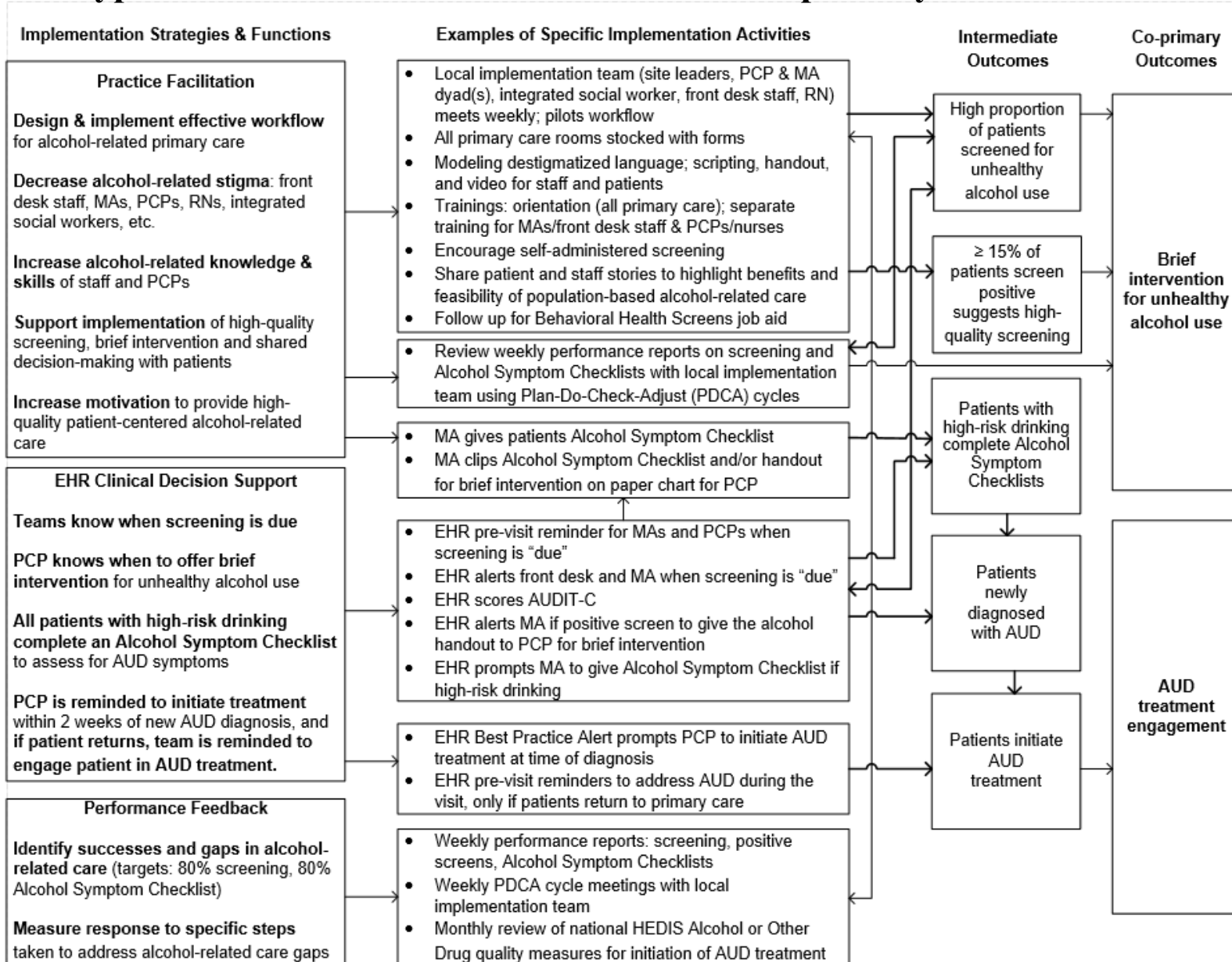
This supplemental material has been provided by the authors to give readers additional information about their work.

eAppendix 1: Usual Care Condition

Usual care included screening with the AUDIT-C on a preventive well-visit questionnaire or online health risk assessment, and ad hoc screening by clinicians with the 10-item AUDIT.¹ KP Washington had clinical guidelines for unhealthy drinking in adults, recommending brief intervention for patients with positive AUDIT-C screens, and the health system’s central quality improvement office had developed optional alcohol-related brief intervention templates as part of the clinical guidelines for alcohol-related care that providers could use for documentation if they chose and “after-visit summaries” for patients. Although KP Washington obtained monthly reports of NCQA’s HEDIS alcohol and drug measures, these were not included in prioritized measures sent to PC leaders monthly.²

Usual Care compared to SPARC Implementation Intervention						
Clinical Care Component	EHR Decision Support Tools		Performance Feedback		Weekly Practice Facilitation with Local Implementation Team for 6 months	
	Usual Care	SPARC Intervention	Usual Care	SPARC Intervention	Usual Care	SPARC Intervention
Alcohol Screening with AUDIT-C	<ul style="list-style-type: none"> - Prompt for check-in staff and MAs to screen at preventive visits only - Ad hoc screening 	<ul style="list-style-type: none"> - Prompt for check-in staff and MAs to screen annually for all primary care visits, using paper-based 7-item behavioral health screen 	None	<ul style="list-style-type: none"> - Weekly feedback - Clinic- and provider-level data - Of patients with primary care visits, # and % with AUDIT-C on day of visit or in the past year (target = 80%) - Medical record numbers of patients with missed screening 	None	<ul style="list-style-type: none"> - Workflow development and scripting to reduce stigma for check-in staff and MAs to give annual screen - Training and education on screening in 1-hour all primary care training and 1-hour check-in staff and MA training
Brief Intervention for Unhealthy Alcohol Use	<ul style="list-style-type: none"> - Documentation templates and after visit summaries created for Unhealthy Drinking in Adults clinical guidelines 	<ul style="list-style-type: none"> - For AUDIT-C scores ≥ 3 women, ≥ 4 men: Prompt for MAs – “Patient needs preventive alcohol advice” and to give provider alcohol handout to cue counseling 	None	None	None	<ul style="list-style-type: none"> - Workflow and job aid development and scripting to reduce stigma, including use of Alcohol and Health handout and Mike Evans video - Training and education on preventive brief intervention in 1-hour all primary care training and 1-hour provider and nurse training
Assessment with Alcohol Symptom Checklist for Alcohol Use Disorder (AUD)	None	<ul style="list-style-type: none"> - AUDIT-C ≥ 7: Prompt for MAs to give patient paper-based 11-item Alcohol Symptom Checklist to assess for AUD 	None	<ul style="list-style-type: none"> - Weekly feedback - Clinic- and provider-level data - Of patients with primary care visits and AUDIT-C ≥ 7, # and % with Alcohol Symptom Checklist on day of visit or in past year (target = 80%) - Medical record numbers of patients with missed Alcohol Symptom Checklists 	None	<ul style="list-style-type: none"> - Workflow development and scripting to reduce stigma for MAs to give Alcohol Symptom Checklist to patients - Training and education for providers: use patient endorsement of symptoms to open the conversation with patient; how to use Alcohol Symptom Checklist to help diagnose AUD
AUD Initiation and Engagement in Treatment	None	<ul style="list-style-type: none"> - Patients with AUD diagnosis: - Prompt (provider) at time of diagnosis to schedule follow-up visit in 14 days or connect patient with integrated social worker (initiation) - Two follow-up prompts (engagement) if patients come in for in-office visits; MAs to give paper-based monitoring tool with AUDIT-C; providers to address AUD during visit or connect with integrated social worker 	<ul style="list-style-type: none"> - No formal feedback - National HEDIS Alcohol and other Drug quality measure available online, not sent to clinic leaders 	<ul style="list-style-type: none"> - Initial development and piloting of feedback regarding types of AUD treatment were stopped when clinical leaders decided to focus on using national HEDIS quality measures during wave 2. - Subsequently, clinic-and provider-level data with monthly feedback of national HEDIS Alcohol or Other Drug quality measure of AUD treatment initiation starting two months into active implementation 	None	<ul style="list-style-type: none"> - Training and education: use patient endorsement of symptoms on the Alcohol Symptom Checklist to open the conversation with patient; 1-hour provider and nurse training on effective treatments for AUD - Job aid on recommended treatment options for AUD

eAppendix 2: Detailed conceptual model of function and format of SPARC intervention and hypothesized effect with intermediate and co-primary outcomes



eAppendix 3: Alcohol Brief Intervention Sources and Natural Language Processing Identification of Brief Intervention

Brief Intervention Sources:

1. SBIRT CPT & HCPCS codes (approved by AMA for billing for screening and brief intervention services):
 - 99408
 - 99409
 - G0396
 - G0397
 - G0442
 - G0443
 - H0049
 - H0050
2. V&Z codes specific to alcohol or drug-related counseling with appropriate DXID code*
 - V65.42 233584 Drug or alcohol risk assessment or counseling
 - V65.42 299233 Encounter for alcoholism counseling
 - V65.42 390438 Alcohol abuse counseling and surveillance
 - V65.42 15209 Counseling on substance use and abuse
 - Z53.20 399407 Alcohol brief intervention refused
 - Z71.4 530641 Alcohol abuse counseling and surveillance
 - Z71.41 328422 Encounter for alcohol abuse counseling and surveillance
 - Z71.41 299233 Encounter for alcoholism counseling
 - Z71.41 390438 Alcohol abuse counseling and surveillance
 - Z71.41 1217441 Encounter for counseling and surveillance for alcohol use disorder
 - Z71.41 1340413 Alcohol abuse counseling and surveillance of alcoholic
 - Z71.41 299302 Encounter for alcohol rehabilitation
 - Z71.89 15209 Counseling on substance use and abuse
 - Z71.89 233584 Drug or alcohol risk assessment or counseling
 - Z91.89 1420990 Advised to abstain from alcohol use
3. Rethinking Drinking: Alcohol and your health procedure order is PE157
4. Natural Language Processing (NLP) Brief Intervention (see details below)

* For the sensitivity measure designed to reflect the NCQA 2018 Unhealthy Alcohol Use Screening and Follow-up codes, we used codes from NCQA specification (with V65.42 codes from ICD-9) and timeframe following visit (60 days following the visit including date of visit) OR repeat negative screen within 60 days

Code	Code System
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- H2036 HCPCS
- T1006 HCPCS
- T1012 HCPCS
- Z71.41 ICD10CM
- Z71.89 ICD10CM
- 20093000 SNOMED CT US Edition
- 23915005 SNOMED CT US Edition
- 24165007 SNOMED CT US Edition
- 64297001 SNOMED CT US Edition
- 386449006 SNOMED CT US Edition
- 408945004 SNOMED CT US Edition
- 408947007 SNOMED CT US Edition
- 408948002 SNOMED CT US Edition
- 413473000 SNOMED CT US Edition
- 707166002 SNOMED CT US Edition
- 429291000124102 SNOMED CT US Edition

Process for Identifying Brief Intervention with Natural Language Processing (NLP)

NLP was used to identify repeated clinical text, or templated language, that indicated alcohol-related brief intervention, operationalized as near-exact text in multiple EHR notes. In the EHR, templated language could be created by individual clinicians and shared with other clinicians, and alcohol-related brief intervention templates were also created by the health system’s central quality improvement office as part of the clinical guidelines for alcohol-related care.

NLP identification of documented brief intervention was a three-step process where we 1) searched for alcohol-related templates that appeared more than 10 times, 2) narrowed down the templates to include only those we considered brief preventive brief intervention based on our definition, and 3) developed an algorithm to search for the templates in notes extracted from during the study period.

Step 1: Search for alcohol-related templates. We identified alcohol-related templates via four mechanisms. First, as mentioned, we had pre-identified brief intervention templates developed for the health system’s clinical guidelines for alcohol. Next, we used NLP to search for notes containing keywords (i.e. alcohol, etoh, drink, brochure, etc.) along with text from the keywords’ immediate context, and manually read through potential templates where the same context appeared more than 10 times. We also saw that brief intervention templates often co-occur with a list of available alcohol resources and hypothesized that additional templates might be identified in notes which contained resource links. We manually reviewed new templates to identify brief intervention templates. Last, we also saw that a link to the Mike Evans alcohol video co-occurred with brief intervention templates and searched for new templates and manually reviewed these to identify additional brief intervention templates.

Step 2: Narrow down repeated templates (≥10 appearances) based on operational definition of preventive brief intervention. Our operational definition for brief intervention was broad, including any recommendation to change drinking (cut back, stop) and/or indication of any brief counseling regarding alcohol, such as an after visit summary discussing risks of alcohol to health or recommended limits (including pregnancy counseling), and included referring patients to the NIAAA “Rethinking Drinking” booklet or a video, “A ReThink of the Way We Drink.”³ We excluded templated recommendations that were part of a string of

recommendations that wasn't all alcohol-related (e.g. falls prevention, sleep); part of a template for a specific medical condition other than alcohol (e.g. diabetes); or part of a treatment plan provided for AUD.

Step 3: Algorithm to search for templates. Once all the brief intervention templates were identified, we developed an algorithm to search for them in notes extracted from 12/24/2014 to 9/15/2018. Because there is some variability in how the individual templates will appear in the text (e.g. templates can be altered by the provider, or the provider is able to fill in additional information), we looked at text similarity using the fuzzywuzzy Python library developed by SeatGeek. This method provides a similarity score ranging from 0 (no similarity) to 100 (perfect similarity). Cut-off scores were inferred from the templates on a template-by-template basis, and very short templates required manual identification of cut-points.

Appendix 4: Definitions on Sensitivity Outcome Measures

Because the optimal EHR-based measure of brief intervention and AUD treatment are unknown, we conducted sensitivity measures with alternative measures of brief intervention and AUD treatment, some specified *a priori*, and others *post hoc*.

Sensitivity measures of prevention. Three measures for brief intervention, defined while the trial was ongoing but before any analyses were conducted, were: 1) a measure with the time window of the NCQA measure for brief intervention that was released during the trial (allowing 60 days for brief intervention after a screen)⁴, 2) one consistent with NCQA brief intervention measure (using a 60 day time window and also not using NLP data to identify brief intervention),⁵ and 3) restricting the primary measure of brief intervention to those documented in primary care.

Sensitivity measures of treatment. Because optimal EHR measures for brief intervention and AUD treatment are unknown, we defined three sensitivity outcome measures of AUD treatment that differed in how primary outcomes were operationalized.⁶ These were developed while the trial was ongoing—but before any analyses were conducted, one reflecting a change in the NCQA AOD measure.⁷ These were 1) a measure that also included phone visits with alcohol and other drug use disorder (AOD) diagnoses as AUD treatment visits, aligning with 2018 NCQA AOD quality measure;⁷ 2) a measure that allowed a longer time window of 30 days for initiation and engagement in the following 60 days (AUD treatment 90 days), as we hypothesized that it might take time to get primary care patients scheduled back to see primary care providers for follow-up; and 3) a stricter measure of AUD treatment engagement that considered visits initiation and engagement in AUD treatment only if they were visits to a behavioral health provider or ones where AUD medications were prescribed in the 44 days after the new diagnosis, or a visit to specialty addiction treatment outside KPWA.

After observing results from our pre-specified analyses, we subsequently defined a “post-hoc” measure for AUD treatment engagement to determine if the lack of evidence of an intervention effect on AUD treatment engagement (despite a statistically significant increase in AUD diagnosis and initiation) reflected the short time window for the primary treatment outcome measure. To that end, we defined a measure that used the stricter definition of AUD treatment defined above, but also allowed a longer, 180-day time window for treatment engagement, allowing telephone visits, and not requiring a “new” diagnosis (i.e., any AUD diagnosis on the day of the visit or in the prior year would indicate treatment for AUD).

We additionally defined explanatory measures for prevention and treatment that evaluated individual components of the composite primary and secondary measures.

eAppendix 5: Statistical Power and Methods

Details of Power Calculations. Calculations were based on a 2-sided test, type 1 error rate of 0.05, and assumed an average of 1,205 patients per site per month and an intraclass correlation coefficient of 0.001, based on baseline data from the included clusters.⁸ The following usual care rates for the main study outcomes were also assumed based on baseline data: 34.2 per 10,000 patients seen for the brief intervention outcome ($0.342\% = 19\% \text{ screened} \times 36\% \text{ screened positive} \times 5\% \text{ counseled}$); and 3.9 per 10,000 for treatment initiation and engagement ($0.039\% = 1.26\% \text{ newly diagnosed} \times 37.5\% \text{ initiating treatment} \times 8.2\% \text{ engaged}$).

Details on statistical models and convergence assessment. Primary statistical analyses used logistic mixed-effects models with patient- and cluster-level random effects that included a binary variable for the SPARC intervention versus Usual Care period and adjusted for the study year of implementation (stratification variable; Year 2-3 [Y2] versus Year 1 [Y1] sites) and indicators for each four months of calendar time. Models were fit in the R statistical program (version 3.5.2) using the lme4 package (version 1.1-19), with model-fitting using the Laplace approximation to the log-likelihood (default setting of the glmer function).

Given the complexity of the models being fit and the large size of the dataset (1,424,897 person-month observations), we applied the following approach to assess convergence of the statistical model for each outcome.

1. Fit the mixed-effect model across all of the available optimization algorithms (for estimating parameter values maximizing the log-likelihood)
2. If the model fitting under different optimization algorithms yielded different parameter estimates for the same outcome in step 1, we re-fit the optimizers using as starting values the parameter estimates obtained from step 1.
3. Repeat step 2 as follows: if the model fitting under different optimization algorithms yielded different parameter estimates in step 2, we re-fit the optimizers using as starting values the parameter estimates obtained from step 2.
4. We then reported the estimate from the model that had the maximal log-likelihood of all the models in steps 1-3.

Note that if model-fitting function reported that the model did not converge for any of the models fit in steps 1-3, then estimates from those models were not considered in Step 4. We also found that for some of the outcomes and some of the optimization algorithms, the model fitting yielded an error such that no parameter estimates were obtained. In particular, for the screening outcome, we were unable to obtain a parameter estimated from the mixed-effect model across any of the outcomes (i.e., the model failed to converge under all optimization algorithms). Consequently, for this secondary outcome, estimates are reported from the corresponding logistic regression model (that did not include random effects) that does not account for within-person and within-cluster correlation.

Sensitivity analyses. First, for each of the outcomes we also report parameter estimates from the corresponding generalized linear model (GLM) that does not include random effects. Second, given our stratified stepped wedge design in which the health system selected the sites that would implement in Year 2 (Y2) it is possible that there could be systematic differences in Y2 sites as compared to the Y1 sites. Our primary model adjusts for differences in outcome rates between these two sets of sites by adjusting for an indicator for whether the site was a Y2 versus Y1 site. However, because all of the Y1 sites are in the SPARC Intervention condition later in the study and similarly all of the Y2 sites are all in the Usual Care condition earlier in the study (See Figure below) it is possible that estimates of the intervention effect could be biased if there are secular changes in outcome rates that differ between these two sets of sites (our primary analysis

assumed a common secular time trend across all sites). To address this issue, we conducted a sensitivity analysis where we excluded follow-up time from Y1 sites during the end of the study period in which no Y1 sites were in Usual Care (denoted by X's in the Figure below), and similarly excluded follow-up time from Y2 sites during the beginning of the study period in which no Y2 sites were in the SPARC Intervention condition. This sensitivity analysis additionally allowed for the effect of calendar time to differ between the two sets of sites. Given the large size of the dataset and convergence challenges in fitting our primary mixed-effect models with non-nested random effects as discussed above, these sensitivity analyses were applied to GLMs that did not include any random effects.

			Intervention time point ("step")							
	Wave	Site	0	1	2	3	4	5	6	7
Y1	1	1, 2, 3					X	X	X	X
	2	4, 5, 6					X	X	X	X
	3	7, 8, 9					X	X	X	X
Y2	4	10, 11, 12	X	X	X					
	5	13, 14, 15	X	X	X					
	6	16, 17	X	X	X					
	7	18, 19	X	X	X					

e-Table 1. Characteristics of patients with visits to sites randomized to different study waves within each stratum (Year 1 vs. Years 2-3 sites)

	Year 1 Sites			Year 2 Sites			
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Total number of patients ^a	51,431 (100)	55,135 (100)	57,330 (100)	99,294 (100)	44,124 (100)	47,848 (100)	33,474 (100)
Number of visits, mean (sd)	3.81 (4.53)	4.14 (4.64)	4.11 (4.59)	4.08 (4.69)	3.76 (4.19)	4.21 (4.73)	4.08 (4.66)
Age, mean (sd)	48.76 (18.47)	49.24 (18.01)	47.92 (17.89)	45.82 (17.59)	46.31 (17.37)	50.07 (17.69)	47.81 (17.77)
Sex ^b							
Female	30023 (58.4)	32614 (59.2)	33507 (58.4)	58966 (59.4)	25266 (57.3)	28257 (59.1)	19894 (59.4)
Male	21408 (41.6)	22521 (40.8)	23822 (41.6)	40327 (40.6)	18858 (42.7)	19591 (40.9)	13580 (40.6)
Hispanic or Latinx/e							
Unknown	3114 (6.1)	3158 (5.7)	3980 (6.9)	5649 (5.7)	2184 (4.9)	2736 (5.7)	3087 (9.2)
Unknown	2255 (4.4)	2567 (4.7)	2635 (4.6)	4856 (4.9)	3063 (6.9)	1924 (4.0)	1334 (4.0)
Race							
Asian	9488 (18.4)	7497 (13.6)	5408 (9.4)	7465 (7.5)	3317 (7.5)	2129 (4.4)	4705 (14.1)
Black or African American	2665 (5.2)	3912 (7.1)	2786 (4.9)	6737 (6.8)	1203 (2.7)	2469 (5.2)	2864 (8.6)
Native Hawaiian or Pacific Islander	418 (0.8)	693 (1.3)	824 (1.4)	948 (1.0)	205 (0.5)	625 (1.3)	631 (1.9)
Native American or Alaskan Native	228 (0.4)	376 (0.7)	509 (0.9)	812 (0.8)	325 (0.7)	531 (1.1)	287 (0.9)
Multiple Race	1465 (2.8)	1728 (3.1)	1897 (3.3)	3324 (3.3)	1163 (2.6)	1779 (3.7)	1108 (3.3)
Other	2156 (4.2)	2098 (3.8)	2345 (4.1)	3641 (3.7)	1302 (3.0)	1533 (3.2)	2164 (6.5)
Unknown	2108 (4.1)	2363 (4.3)	2600 (4.5)	4598 (4.6)	2793 (6.3)	1814 (3.8)	1266 (3.8)
White	32903 (64.0)	36468 (66.1)	40961 (71.4)	71769 (72.3)	33816 (76.6)	36968 (77.3)	20449 (61.1)
Needs Interpreter	2564 (5.0)	2592 (4.7)	1542 (2.7)	2032 (2.0)	663 (1.5)	587 (1.2)	2112 (6.3)
Insurance Type							
Commercial	29645 (57.6)	32820 (59.5)	36054 (62.9)	61916 (62.4)	27541 (62.4)	28337 (59.2)	21758 (65.0)
Medicaid	1033 (2.0)	2020 (3.7)	1363 (2.4)	4373 (4.4)	1885 (4.3)	1444 (3.0)	889 (2.7)
Medicare	10841 (21.1)	12145 (22.0)	11022 (19.2)	16775 (16.9)	7157 (16.2)	11461 (24.0)	6171 (18.4)
Other	1529 (3.0)	1577 (2.9)	1623 (2.8)	5131 (5.2)	1889 (4.3)	1385 (2.9)	848 (2.5)
Private Pay	8383 (16.3)	6573 (11.9)	7268 (12.7)	11099 (11.2)	5652 (12.8)	5221 (10.9)	3808 (11.4)
Conditions, symptoms, or behaviors, past year ^c							
Tobacco use ^d	4358 (8.5)	6336 (11.5)	6365 (11.1)	10563 (10.6)	4278 (9.7)	6247 (13.1)	4101 (12.3)
Alcohol use disorder	623 (1.2)	697 (1.3)	663 (1.2)	1468 (1.5)	521 (1.2)	674 (1.4)	458 (1.4)
Cannabis use disorder	180 (0.3)	283 (0.5)	266 (0.5)	640 (0.6)	242 (0.5)	269 (0.6)	146 (0.4)
Drug use disorder	152 (0.3)	189 (0.3)	183 (0.3)	447 (0.5)	177 (0.4)	188 (0.4)	103 (0.3)
Opioid use disorder	254 (0.5)	283 (0.5)	270 (0.5)	634 (0.6)	246 (0.6)	351 (0.7)	170 (0.5)
Stimulant use disorder	75 (0.1)	80 (0.1)	82 (0.1)	209 (0.2)	79 (0.2)	95 (0.2)	47 (0.1)
Depression	7433 (14.5)	9150 (16.6)	9125 (15.9)	18001 (18.1)	7238 (16.4)	8831 (18.5)	5110 (15.3)

Anxiety	5902 (11.5)	6981 (12.7)	7482 (13.1)	14640 (14.7)	6153 (13.9)	6842 (14.3)	4028 (12.0)
Eating disorder	135 (0.3)	133 (0.2)	91 (0.2)	331 (0.3)	112 (0.3)	105 (0.2)	63 (0.2)
Serious mental illness	994 (1.9)	1306 (2.4)	1184 (2.1)	2072 (2.1)	806 (1.8)	1324 (2.8)	663 (2.0)
Attention deficit disorder	1038 (2.0)	1019 (1.8)	1184 (2.1)	2287 (2.3)	1041 (2.4)	1063 (2.2)	575 (1.7)
Insomnia	2313 (4.5)	2792 (5.1)	2808 (4.9)	5619 (5.7)	2271 (5.1)	2823 (5.9)	1425 (4.3)
Other mental health conditions	279 (0.5)	276 (0.5)	284 (0.5)	456 (0.5)	198 (0.4)	256 (0.5)	181 (0.5)
Cardiovascular conditions ^e	11593 (22.5)	14367 (26.1)	14757 (25.7)	21325 (21.5)	8938 (20.3)	13671 (28.6)	8295 (24.8)
Gastrointestinal conditions ^f	561 (1.1)	800 (1.5)	623 (1.1)	1221 (1.2)	432 (1.0)	694 (1.5)	395 (1.2)
Diabetes	4293 (8.3)	5653 (10.3)	5678 (9.9)	7620 (7.7)	3086 (7.0)	5059 (10.6)	3328 (9.9)
Renal disease	2605 (5.1)	3040 (5.5)	2863 (5.0)	3639 (3.7)	1329 (3.0)	2715 (5.7)	1539 (4.6)
Cancer ^g	1428 (2.8)	1609 (2.9)	1399 (2.4)	2545 (2.6)	1126 (2.6)	1464 (3.1)	726 (2.2)
Pain conditions	25133 (48.9)	27959 (50.7)	28414 (49.6)	50489 (50.8)	21407 (48.5)	26335 (55.0)	16475 (49.2)

^a Patients could have a visit in both periods (total number of patients with a visit = 333,596; number of patients with visits in both periods = 150,451)

^b Unknown sex: 1 patient (0.0%) in Usual Care period and 2 patients (0.0%) in SPARC Intervention period

^c All conditions, symptoms, or behaviors were in the year prior to and on day of the visit for each patients' initial primary care visit except for alcohol, cannabis, drug, opioid, and stimulant use disorders which include only active use disorders (excludes remission) the year prior to each patients' initial primary care visit

^d Unknown tobacco use: 23,996 (9.4%) in Usual Care period and 21,771 (9.5%) in SPARC Intervention period

^e Cardiovascular conditions include hypertension, myocardial infarction, coronary heart disease, peripheral vascular disease, cardiovascular disease

^f Gastrointestinal conditions include liver disease, peptic ulcer disease and hepatitis C, pancreatitis

^g Cancer includes any malignancy

e-Table 2. Prevention outcomes: parameter estimates under primary, secondary, explanatory, and sensitivity analysis measures

Measure Type ^a	Outcome Measure	Intervention effect ^b				
		log OR	SE	z	P value	OR
Secondary	Screening for unhealthy alcohol use documented	2.95	0.01	380.18	<0.0001	19.02
Secondary	Screened positive most recent visit	3.7	0.02	165.82	<0.0001	40.41
Secondary	High positive screen most recent visit	2.52	0.07	38.57	<0.0001	12.43
Explanatory	Any positive screen within prior year	3.69	0.02	167.6	<0.0001	39.92
Co-Primary	Brief intervention within 14 days	2.83	0.11	26.21	<0.0001	16.89
Sensitivity	Extends time window for brief intervention to 60 days	2.5	0.11	22.83	<0.0001	12.12
Sensitivity	Time window for brief intervention 60 days and NLP data not used to identify brief intervention	1.21	0.05	24.42	<0.0001	3.35
Sensitivity	Restricted to brief intervention documented in primary care	2.32	0.11	21.42	<0.0001	10.13

Definitions of measures:

Screened for unhealthy alcohol use: patients had an alcohol screen (AUDIT-C) at the visit or in prior year;

Screened positive most recent visit: patients had AUDIT-C ≥ 3 women or ≥ 4 men on the most recent screen at the visit or in prior year;

High positive screen most recent visit: patients had AUDIT-C ≥ 7 on the most recent screen at the visit or in prior year;

Any positive screen within prior year: patients had AUDIT-C ≥ 3 women or ≥ 4 men at the visit or in prior year;

Brief intervention within 14 days (main outcome; bold in table): patients screened positive at the visit or in the prior year (AUDIT-C ≥ 3 women or ≥ 4 men) and had documented brief intervention (see text and eSupplement 3 for definition of brief intervention) at the visit or within 14 days after the visit.

^a Primary and Secondary Measures correspond to measures presented in Table 2 of manuscript; Explanatory measures are components of primary or secondary measures; Definitions of sensitivity measures in eSupplement 4

^b Estimates obtained from a logistic mixed-effect regression model adjusted for the stratification variable (Y2 versus Y1 site), calendar time (indicator variable for each 4 months), and with person- and site-level random effects

OR = odds ratio; SE = standard error

e-Table 3. Treatment outcomes: parameter estimates under primary, secondary, explanatory, and sensitivity analysis measures

Measure Type ^a	Outcome Measure	Intervention effect ^b				
		log OR	SE	z	P value	OR
Explanatory	High positive screen within prior year	2.33	0.06	38.9	<0.0001	10.25
Explanatory	DSM-5 Alcohol Symptom Checklist within prior year	6.7	0.14	49.13	<0.0001	811.53
Secondary	DSM-5 Alcohol Symptom Checklist documented	7.82	0.17	46.56	<0.0001	2492.25
Explanatory	AUD diagnosis within past year	0.14	0.04	3.22	0.001	1.15
Explanatory	AUD diagnosis on day of visit	0.18	0.06	3.07	0.002	1.2
Explanatory	AUD diagnosis in year prior to visit	0.07	0.04	1.73	0.084	1.08
Secondary	New AUD diagnosis	0.25	0.08	2.99	0.003	1.28
Secondary	AUD treatment initiation	0.36	0.18	2.04	0.042	1.43
Co-Primary	AUD treatment engagement	-0.38	0.37	-1.03	0.3	0.68
Sensitivity	Includes telephone visits	-0.59	0.34	-1.72	0.086	0.56
Sensitivity	Longer 90-day window for initiation and engagement visits	-0.42	0.29	-1.41	0.16	0.66
Sensitivity	Stricter definition of AUD treatment by restricting initiation and engagement visits to behavioral health providers and specialty addiction treatment only or AUD medications	-0.35	0.36	-0.98	0.33	0.71
Post-hoc	Stricter definition of AUD treatment, and includes telephone visits, a longer 180-day window for initiation and engagement visits, and does not require AUD diagnosis to be “new”	0.25	0.16	1.54	0.12	1.28

Definitions of measures:

High positive screen within prior year: patients had AUDIT-C ≥ 7 at the visit or in prior year;

DSM-5 Alcohol Symptom Checklist within prior year: patients had a DSM-5 Alcohol Symptom Checklist documented at the visit or in prior year;

DSM-5 Alcohol Symptom Checklist documented: patients had a high positive alcohol screen (AUDIT-C ≥ 7) at the visit or in prior year and a DSM-5 Alcohol Symptom Checklist documented at the visit or in prior year;

AUD diagnosis within past year: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented at the visit or in prior year;

AUD diagnosis on day of visit: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented at the visit;

AUD diagnosis in year prior to visit: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented in the year prior to the visit (not including the day of the visit)

New AUD diagnosis: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented at the visit and no AUD diagnosis in prior year;

AUD treatment initiation: a new AUD diagnosis was documented at a visit and treatment was documented in a separate visit on the day of diagnosis or within 14 days after the visit (see text for definition of treatment);

AUD treatment engagement (main outcome; bold in table): AUD treatment initiation (above) with 2 more treatment visits in the 30 days following initiation.

^a Primary and Secondary Measures correspond to measures presented in Table 3 of manuscript; Explanatory measures are components of primary or secondary measures; Definitions of sensitivity measures and post-hoc measures in eSupplement 4

^b Estimates obtained from a logistic mixed-effect regression model adjusted for the stratification variable (Y2 versus Y1 site), calendar time (indicator variable for each 4 months), and with person- and site-level random effects

OR = odds ratio; SE = standard error

e-Table 4. Parameter estimates for prevention and treatment outcomes under sensitivity analyses fitting generalized linear models

Measure Type ^a	Outcome Measure	Primary model ^b				Addressing stratified design ^c			
		log OR	SE	P value	OR ^d	log OR	SE	P value	OR ^d
Prevention Outcomes									
Secondary	Screened for unhealthy alcohol use	2.95	0.01	<0.0001	19.02	2.79	0.01	<0.0001	16.28
Secondary	Screened positive most recent visit	1.77	0.01	<0.0001	5.87	1.74	0.01	<0.0001	5.69
Secondary	High positive screen most recent visit	1.24	0.03	<0.0001	3.44	1.22	0.04	<0.0001	3.4
Explanatory	Any positive screen within prior year	1.7	0.01	<0.0001	5.45	1.67	0.01	<0.0001	5.3
Co-primary	Brief intervention within 14 days	1.82	0.06	<0.0001	6.14	1.78	0.08	<0.0001	5.93
Sensitivity	Extends time window for brief intervention to 60 days	1.8	0.06	<0.0001	6.08	1.78	0.08	<0.0001	5.92
Sensitivity	Time window for brief intervention 60 days and NLP data not used to identify brief intervention	1.05	0.03	<0.0001	2.85	1.06	0.04	<0.0001	2.89
Sensitivity	Restricted to brief intervention documented in primary care	1.82	0.06	<0.0001	6.14	1.78	0.08	<0.0001	5.93
Treatment Outcomes									
Explanatory	High positive screen within prior year	1.09	0.03	<0.0001	2.99	1.13	0.04	<0.0001	3.1
Explanatory	DSM-5 Alcohol Symptom Checklist within prior year	2.15	0.05	<0.0001	8.6	1.79	0.06	<0.0001	5.97
Secondary	DSM-5 Alcohol Symptom Checklist documented	2.47	0.06	<0.0001	11.77	2.06	0.07	<0.0001	7.84
Explanatory	AUD diagnosis within past year	0.03	0.02	0.083	1.04	0.06	0.02	0.012	1.06
Explanatory	AUD diagnosis on day of visit	0.07	0.03	0.055	1.07	0.09	0.04	0.032	1.1
Explanatory	AUD diagnosis in year prior to visit	0.02	0.02	0.28	1.02	0.06	0.03	0.023	1.06
Secondary	New AUD diagnosis	0.1	0.05	0.061	1.1	0.06	0.07	0.37	1.06
Secondary	AUD treatment initiation	0.19	0.12	0.097	1.21	0.19	0.15	0.22	1.21
Co-primary	AUD treatment engagement	-0.08	0.23	0.75	0.93	0.08	0.3	0.79	1.08
Sensitivity	Includes telephone visits	-0.22	0.22	0.31	0.8	-0.18	0.27	0.51	0.84
Sensitivity	Longer 90-day window for initiation and engagement visits	-0.23	0.19	0.23	0.79	-0.19	0.24	0.42	0.82

Sensitivity	Stricter definition of AUD treatment by restricting initiation and engagement visits to behavioral health providers and specialty addiction treatment only or AUD medications	-0.19	0.33	0.57	0.83	0.25	0.4	0.53	1.28
Post-hoc	Stricter definition of AUD treatment, and includes telephone visits, a longer 180-day window for initiation and engagement visits, and does not require AUD diagnosis to be “new”	0.27	0.1	0.007	1.31	0.47	0.13	0.0002	1.6

Definitions of measures:

Screened for unhealthy alcohol use: patients had an alcohol screen (AUDIT-C) at the visit or in prior year;

Screened positive most recent visit: patients had AUDIT-C ≥ 3 women or ≥ 4 men on the most recent screen at the visit or in prior year;

High positive screen most recent visit: patients had AUDIT-C ≥ 7 on the most recent screen at the visit or in prior year;

Any positive screen within prior year: patients had AUDIT-C ≥ 3 women or ≥ 4 men at the visit or in prior year;

Brief intervention within 14 days (main outcome; bold in table): patients screened positive at the visit or in the prior year (AUDIT-C ≥ 3 women or ≥ 4 men) and had documented brief intervention (see text and eSupplement 3 for definition of brief intervention) at the visit or within 14 days after the visit.

High positive screen within prior year: patients had AUDIT-C ≥ 7 at the visit or in prior year;

DSM-5 Alcohol Symptom Checklist within prior year: patients had a DSM-5 Alcohol Symptom Checklist documented at the visit or in prior year;

DSM-5 Alcohol Symptom Checklist documented: patients had a high positive alcohol screen (AUDIT-C ≥ 7) at the visit or in prior year and a DSM-5 Alcohol Symptom Checklist documented at the visit or in prior year;

AUD diagnosis within past year: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented at the visit or in prior year;

AUD diagnosis on day of visit: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented at the visit;

AUD diagnosis in year prior to visit: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented in the year prior to the visit (not including the day of the visit)

New AUD diagnosis: International Classification of Disease 9th or 10th edition (ICD) code for an AUD documented at the visit and no AUD diagnosis in prior year;

AUD treatment initiation: a new AUD diagnosis was documented at a visit and treatment was documented in a separate visit on the day of diagnosis or within 14 days after the visit (see text for definition of treatment);

AUD treatment engagement (main outcome; bold in table): AUD treatment initiation (above) with 2 more treatment visits in the 30 days following initiation.

^a Primary and Secondary Measures correspond to measures presented in Tables 2 and 3 of manuscript; Explanatory measures are components of primary or secondary measures; Definitions of sensitivity measures and post-hoc measures in eSupplement 4

^b Same covariate adjustment as in primary analysis but using a regular logistic regression without any random effects

^c Allows separate time trends by each stratum of sites (Year 2 [Y2] or Year 1 [Y1]) and excludes follow-up time where each group of sites is either only in the Usual Care or only in the SPARC Intervention condition (see eSupplement 5)

^d In comparison to the primary mixed-effect model, estimates of the log OR and OR are expected to be smaller in magnitude in the corresponding logistic regression model that does not include any random effects⁹

OR = odds ratio; SE=standard error

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