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Initiation and engagement as mechanisms for change caused by collaborative care in opioid and alcohol use disorders

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Abstract

Background: To assess the mechanism by which a collaborative care (CC) intervention improves self-reported abstinence among primary care patients with opioid and alcohol use disorders (OAUd) compared to treatment as usual.

Methods: Secondary data analysis of SUMMIT, a randomized controlled trial of CC for OAUd. Participants were 258 patients with OAUd receiving primary care at a multi-site Federally Qualified Health Center. Using a mediation analysis decomposition of a total effect into a mediated and a direct effect, we examined the effect of CC on abstinence at six months, attributable to the HEDIS treatment initiation and engagement measures for the total sample, for individuals with alcohol use disorders alone, and for those with a co-morbid opioid use disorder.

Results: Although the CC intervention led to an increase in both initiation and engagement, among the full sample, only initiation mediated the effect of the intervention on abstinence (3.8%, CI=[0.4%, 8.3%]; 32% proportion of the total effect). In subgroup analyses, among individuals with comorbid alcohol and opioid use disorders, almost 100% of the total effect was mediated by engagement, but the effect was not significant. This was not observed among the alcohol use disorder only group.

Conclusions: Among primary care patients with OAUds, treatment initiation partially mediated the effect of CC on abstinence at 6-months. The current study emphasizes the importance of primary care patients returning for a second substance-use related visit after identification. CC may work differently for people with co-morbid opioid use disorders vs. alcohol use disorders alone.

Keywords

Opioid and alcohol use disorders; Collaborative care intervention; Treatment initiation; Engagement; Mediation

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Contributors

Each author has contributed significantly to the work and agrees to the submission. All authors have read and approve the final manuscript.

Conflict of interest

No conflict declared.

1. Introduction

Opioid and alcohol use disorders (OAUDs) contribute to high rates of morbidity and mortality in the US (Degenhardt et al., 2011; Roerecke and Rehm, 2013; Ronan and Herzig, 2016; Substance Abuse and Mental Health Services Administration, 2018). Alcohol use disorders affect an estimated 15.8 million people, an estimated 1.9 million people abuse or are dependent on prescription opioids and 323,000 are dependent on heroin (Center for Behavioral Health Statistics and Quality, 2015; Substance Abuse and Mental Health Services Administration, 2014). OAUDs also frequently co-occur with each other and with other substance use disorders (SUDs) (Grant et al., 2015), making them more challenging to treat and more likely to be persistent and severe (McCabe and West, 2017; Moss et al., 2015; Upah et al., 2015; Witkiewitz and Vowles, 2018).

Treatments for OAUDs (i.e., medications, psychotherapy) are effective, yet only a small percentage of those needing treatment receive it (Blanco et al., 2015, 2013; Compton et al., 2007; Grella et al., 2009; Hasin et al., 2007; Substance Abuse and Mental Health Services Administration, 2018). Of adults with substance use disorders (SUDs), most do not perceive a need for treatment, and among those who do perceive a need but do not obtain treatment, multiple barriers, such as long waiting lists, stigma and the lack of treatment availability, hinder treatment entry into specialty care settings (Appel et al., 2004; Cunningham et al., 1993; Grant, 1997). Further, many people who need treatment do not know how or where to seek it (Park-Lee et al., 2015; Substance Abuse and Mental Health Services Administration, 2013) and may not be motivated to begin treatment (Substance Abuse and Mental Health Services Administration, 2014).

Primary care offers an important setting in which to identify OAUD and provide treatment because most individuals (82%) visit a PC provider at least once a year (Blackwell et al., 2014). Furthermore, the 2010 Patient Protection and Affordable Care Act (ACA) has several financing and reimbursement provisions that encourage treatment of behavioral health conditions in primary care (Buck, 2011; Croft and Parish, 2013), and these disorders can be effectively treated in primary care with FDA-approved medications (Balhara, 2014; Doolittle and Becker, 2011; Drainoni et al., 2014; Mauger et al., 2014; Myles et al., 2000; Schackman et al., 2012; Tofghi et al., 2014). Despite this, few primary care providers offer OAUD treatment. Among community health centers, only 21% report offering any SUD treatment services, and, when available, about half rely exclusively on providing a referral to specialty SUD treatment (Gurewich et al., 2012; HRSA Health Center Program, 2017; Shin et al., 2013; Urada et al., 2014).

Collaborative care (CC) approaches have been used to improve the identification of individuals with behavioral health disorders in primary care, assess for the presence of the disorder and facilitate the delivery of appropriate evidence-based care, resulting in improved patient outcomes (Archer et al., 2012; Katon and Guico-Pabia, 2011). Based on the Chronic Care Model developed by Wagner et al. (2001), CC is a systematic approach to organizing and coordinating care for patients with complex conditions (Katon et al., 2010). It consists of four core elements: (1) Team-driven: a behavioral health team, including a care coordinator, or care manager is integrated into the medical team to increase engagement in

care and develop patient-centered care plans; (2) Population-focused: the team provides care to a defined group of patients (e.g., all patients with OAUDs); (3) Measurement-based: The team uses systematic, patient-reported measures to drive clinical decision-making; and (4) Evidence-based: the team facilitates use of evidence-based practices in the clinical setting (American Psychiatric Association and Academy of Psychosomatic Medicine, 2016; Katon, 2003, 2009; Unutzer et al., 2002). In addition to its impact on treatment for depression and anxiety disorders, CC has recently been found to improve abstinence in patients with OAUDs presenting to community health clinics for primary care (Watkins et al., 2017b).

Little is known about the mechanisms underlying the relationship between CC and improved patient outcomes. CC may work by increasing the likelihood of patients receiving evidence-based treatment. In one study of telemedicine-based CC for PTSD, attendance at 8 or more sessions of cognitive processing therapy fully mediated the CC intervention effect at 12 months (Fortney et al., 2015). To our knowledge, no similar are studies examining whether treatment utilization mediates the relationship between CC and improved depression or substance use outcomes. However, studies conducted to validate treatment utilization indicators as measures of the quality of SUD treatment, suggest that treatment initiation and engagement measures are associated with improved outcomes (Dunigan et al., 2014; Garnick et al., 2014; Garnick et al., 2007; Garnick et al., 2012; Harris et al., 2010, 2015). Treatment initiation is defined as at least one SUD-related treatment visit within 14 days of identification, and engagement is defined as receiving an additional two SUD-related treatment visits within 30 days after the initiation visit. These findings suggest that initiation of and engagement in OAUD care could mediate the relationship between primary-care based CC and improved OAUD treatment outcomes.

We report here on secondary data analyses of the Substance Use Motivation and Medication Integrated Treatment (SUMMIT) randomized controlled trial (RCT) (Watkins et al., 2017b). We estimated the efficacy of CC in increasing initiation of and engagement in evidence-based OAUD treatment (i.e., either a brief psychotherapy treatment and/or medication-assisted treatment (MAT) with either sublingual buprenorphine/naloxone (BUP/NX) for opioid use disorders or long-acting injectable naltrexone (XR-NTX) for alcohol use disorders (Heinzerling et al., 2016; Osilla et al., 2016), and examined the extent to which initiation and engagement mediated the effect of CC on abstinence from alcohol and opioids. Because the study population consisted of individuals with opioid and/or alcohol use disorders who had different clinical characteristics, we also conducted subgroup analyses with two non-overlapping groups: those with only an alcohol use disorder, and those with an opioid use disorder, nearly all of whom also had a co-morbid alcohol use disorder. We hypothesized that receiving the CC intervention would be associated with treatment initiation and engagement, that initiation of and engagement in OAUD treatment would be associated with increased abstinence, and that initiation of and engagement in OAUD treatment would mediate the relationship between the CC intervention and abstinence.

2. Methods

2.1. Participants and procedures

Participants from the two largest clinics of a federally qualified health center (FQHC) in Los Angeles County were recruited for the SUMMIT randomized controlled trial. Between June 3, 2014, and January 15, 2016, all adult patients attending a primary care visit who screened positive for risky or worse substance use in the past 3-months using a 3-question screener based on the NIDA quick screen (National Institute on Drug Abuse, 2017) were assessed for eligibility. Inclusion criteria were: aged 18 or older, meeting criteria for an opioid and/or alcohol use disorder diagnosis based on the NIDA-modified ASSIST (National Institute on Drug Abuse, 2017) and later confirmed using the Comprehensive International Diagnostic Interview (CIDI), version 3.0 (Forman et al., 2004; Haro et al., 2006); English or Spanish-speaking, and willing to be randomized. Patients with functional impairment from bipolar disorder or schizophrenia (Arbuckle et al., 2009; Luciano et al., 2010), patients reporting abstinence from opioids and/or alcohol in the previous 30 days, and/or current enrollment in a SUD treatment program were excluded. Of the 745 patients with a positive screen, 452 were eligible for study participation, 377 were enrolled, and 261 completed a 6-month follow-up interview. Three participants were dropped from these analyses because of missing data making the analytic sample size equal to 258. More than half of the sample ($n = 149$) had alcohol use disorder only while only 4 had an opioid use disorder only and the remaining 105 had both disorders. A detailed description of the study and patient characteristics have been previously published (Ober et al., 2015; Watkins et al., 2017b). The RAND Institutional Review Board approved the study on April 26, 2012.

2.2. Intervention

The CC intervention is based on principles of the chronic care model (Bodenheimer et al., 2002a, b) which is designed to facilitate the integration of behavioral health treatment into primary care. The CC intervention (Ober et al., 2015; Watkins et al., 2017a, b) included the institution of a care coordinator; a population-based management approach in which the care coordinators entered all patients into a clinical registry and tracked patients over time; measurement-based care; and integration of addiction expertise by an addiction medicine physician and a clinical psychologist affiliated with the Motivational Interviewing Network of Trainers, who provided training and consultation to providers at the FQHC. The care coordinator met with CC participants when they screened positive for an OAUD to assess motivation and encourage patients to meet with a behavioral health therapist for evaluation and treatment. Care coordinators entered all CC patients into an electronic registry that tracked treatment progress and prompted coordinators to reach out to patients with missed visits. The study's two care coordinators were paraprofessionals with a high school degree who received 2-days of motivational interviewing training. The five behavioral health therapists randomized to the CC condition received 2-days of training in the brief therapy (Osilla et al., 2016, 2018) and one hour of weekly group supervision from a clinical psychologist affiliated with the Motivational Interviewing Network of Trainers. Medical providers were not randomized; all ($N = 28$) were offered MAT training; 24 participated in XR-NTX training and 18 participated in training on BUP/NX (7 non-physicians were not eligible to receive an X-waiver¹ and 3 physicians were not trained).

2.3. Usual care (comparison) condition

Usual care participants were told that the clinic provided OAUD treatment, given a phone number for appointment scheduling and a list of community referrals, and asked if they needed to speak with an on-call behavioral health therapist immediately. They did not receive any additional outreach from CCs or therapists/providers trained in the brief therapy.

2.4. Measures

2.4.1. Outcome—For these analyses, the primary outcome measure was self-reported 30-day abstinence from all opioids (defined as non-medically prescribed painkillers, heroin or opium) and alcohol at 6-months. The TimeLine Follow-Back (TLFB) method (Sobell and Sobell, 1992) was used to assess past 30-day opioid and alcohol use; we created a binary measure of abstinence.

2.4.2. Treatment initiation and engagement—Initiation and engagement measures were defined per the Healthcare Effectiveness Data and Information Set (HEDIS) specifications (National Quality Measures Clearinghouse, 2014, 2015). Initiation was defined as receiving, within 14 days of identification of an OAUD by a medical assistant, either a medical visit during which alcohol or opioid use or MAT were discussed, a brief therapy visit, and/or the receipt of MAT for OAUD (Heinzerling et al., 2016). Engagement was defined as receiving at least 2 additional visits within 30-days of initiation; both were binary measures. Visit data were obtained from electronic medical record administrative files, cross referenced with a pharmacy log and a chart review of electronic medical record notes. Small sample size precluded examining each type of visit (brief therapy, pharmacotherapy) separately.

2.4.3. Covariates—Model covariates included participants' age, race, ethnicity, receipt of substance abuse treatment in the past 12 months, and clinic fixed effects.

2.5. Statistical analysis

2.5.1. Descriptive statistics—We described sample characteristics using baseline data by calculating proportions for categorical variables and means and standard deviations for continuous variables.

2.5.2. Mediation analysis—We conducted a series of mediation analyses (Baron and Kenny, 1986; Imai et al., 2010) to examine the role of evidence-based OAUD treatment initiation and engagement in mediating the impact of CC on participant's OAUD use. Fig. 1 shows our mediation analysis model.

For each of the two hypothesized mediator variables (initiation and engagement) (M), we used regression models to test whether the mediators were affected by the CC intervention

¹In the U.S., medical providers are permitted to dispense or prescribe approved Schedule III, IV, and V narcotic medications (i.e., those that have a lower risk for abuse, like buprenorphine/naloxone) in settings other than an opioid treatment program (OTP). In order to prescribe or dispense buprenorphine, medical providers must qualify for an "X-waiver" which includes completing eight hours of required training or being certified in addiction medicine or addiction psychiatry and applying for the waiver with the drug enforcement agency (Substance Abuse and Mental Health Services Administration, 2016). Buprenorphine waiver management. <https://www.samhsa.gov/medication-assisted-treatment/buprenorphine-waiver-management>. Accessed on December 20, 2016.

(T) and also influenced abstinence (Y) in a way that explained in whole or in part the effect of the study condition. First, in an outcome model, we regressed the CC intervention and each mediator on the outcome, Y, controlling for covariates specified in 2.5.3 and summarized in X:

$$g(Y) = \mu + \lambda \text{ Condition} + \beta \text{ Mediator} + \gamma_1 X + \varepsilon_Y \quad (1)$$

where $g()$ is the non-linear logistic regression transformation used because of the binary outcome (i.e., abstinence) investigated in this study. Then, in a mediator model, we regressed study condition on each mediator, M, again controlling for the covariates X:

$$\text{Mediator} = \nu + \alpha \text{ Condition} + \gamma_2 X + \varepsilon_m \quad (2)$$

where the outcome is binary, estimation of these parameters is achieved using the counterfactual framework of causal mediation effects proposed by Imai et al. (2010). In this analysis, an observed CC intervention effect (the total effect) is decomposed into a mediated effect, or the part of the effect caused by influences of the intervention on the mediator (a combination of γ_2 and β); and the direct effect or any leftover effect after accounting for the mediator impact (a transformation of λ). The total effect is the sum of the mediated and the direct effect. We conducted the mediation analyses on the total sample ($N = 258$), the alcohol only subgroup ($N = 149$) and the group with comorbid alcohol and opioid use disorders ($N = 105$). The 4-patients with an opioid use disorder alone were dropped from the stratified analysis due to the low sample size.

Statistical analyses were conducted using R software (version 3.3.0) and the R package for Causal Mediation Analysis (Tingley et al., 2014) along with a non-parametric bootstrap procedure with 10,000 replications to determine statistical significance.

3. Results

3.1. Sample characteristics

Of the 377 patients enrolled in the study, 119 were lost at follow up. Women (24% vs. 13%), blacks (17% vs. 6%), non-homeless (61% vs. 28%) and patients with alcohol use disorder (58% vs. 45%) were more likely to participate in a follow up interview. Table 1 shows the descriptive characteristics of the 258 study participants who completed the 6-month follow-up assessment. Forty-one percent of the analytic sample was Caucasian, 17% African American, 13% multi-race and 29% other race. Twelve percent had received specialty SUD treatment in the past 12 months; none were currently in treatment. The average study participant was 42 years old.

We found significant differences in initiation and engagement by study condition and diagnosis. Participants in the CC condition were more likely to initiate OAUD care within 14 days of identification and engage in treatment within 30 days than participants in the usual care condition (36.8% vs. 17.2%, $p < 0.001$; 19.1% vs. 6.8%, $p = 0.005$, respectively). After

controlling for covariates that were significantly different between the CC and UC groups (i.e., age, race, receipt of addiction treatment in the prior 12 months, clinic site; *data not shown*), the association persisted and was also seen when the sample was stratified by diagnosis (i.e., alcohol use disorder only; and co-morbid alcohol and opioid use disorders). Almost all the participants with opioid use disorder also had an alcohol use disorder.

3.2. Collaborative care intervention total effect and its decomposition into mediated and direct effects

Table 2 summarizes the results of both the outcome model (columns 2–5) and the mediator model (columns 6–9) for the combined sample containing participants with all disorders, and Table 3 reports the transformation of those model results into the decomposition of the intervention (total) effect into a mediated and a direct effect. The CC intervention increased the likelihood of initiation in the mediator model ($\gamma_2 = 1.04$, $p < 0.01$) and the mediator increased the likelihood of abstinence after controlling for the CC intervention in the outcome model ($\beta = 1.21$, $p < 0.001$). These models resulted in effect decompositions showing that in total, CC led to an increase in abstinence by 11.7%, and that a significant portion of that total effect (3.8%, $CI = [0.4\%, 8.3\%]$; or, 32% proportion of the total effect) was mediated by the initiation of any OAUD treatment within 14 days (Table 3, columns 2–3). The remaining direct CC effect (i.e., the effect of all the other mechanisms induced by CC) was an increase of 7.9% in abstinence but was non-significant. When the engagement was considered as a mediator, even though the causal pathway showed that the CC intervention first led to an increase in the likelihood of engagement ($\gamma_2 = 2.04$, $p < 0.01$), the effect of the mediator on the outcome was rendered insignificant after controlling for the intervention ($\beta = 0.40$, $p = 0.37$). As such, the combination of those two revealed that the total CC effect of around 12% increase in outcome was not mediated by engagement ($p = 0.37$), but the direct effect was borderline significant in the order of 10.7%, $CI = [-0.1\%, 21.2\%]$.

To further investigate the results, we conducted an exploratory effect decomposition analysis within the groups of participants who only had an alcohol use disorder ($n = 149$) as well as among the group of participants who had both alcohol and opioid use disorders ($n = 105$). Only 4 participants had an opioid use disorder only and as such this subgroup analysis was not conducted for such a small sample. Within the alcohol use disorder only group, the total effect of the CC intervention was larger than the total effect seen in the full sample (19.4% increase in abstinence vs. 11.7% observed in the full sample), however neither the initiation nor engagement mediated effect was statistically significant (i.e., the effect of the CC intervention on abstinence among alcohol use disorder participants was not explained by treatment initiation or engagement).

Among the alcohol and opioid comorbid group, the total effects were small and non-significant in the order of a 3%–4% increase in abstinence. For the engagement and initiation mediators in this subgroup, even though not significant, the mediated effects were observed as 3.2% ($CI = [-0.8\%, 9.6\%]$) and 3.3% ($CI = [-3.8\%, 11.0\%]$) respectively or almost 100% and 87% of the total effects for each of these mediators.

4. Discussion

The analyses described above were conducted to examine whether two measures of treatment utilization, initiation and engagement, mediated the effect of a collaborative care (CC) intervention to address alcohol and/or opioid use disorders (OAUD) in primary care on abstinence. Among the full sample, the CC intervention increased the proportion of individuals initiating and engaging with OAUD treatment and reporting 30-day abstinence at six months. Mediation analyses indicated that OAUD treatment initiation, but not OAUD treatment engagement, partially mediated the effect that the CC intervention had on abstinence. While the CC intervention's effect was to cause a substantial increase in abstinence in general, 32% of that increase is attributable to the intervention causing an increase in initiation. In contrast, engagement did not mediate the effects of the CC intervention on abstinence.

Mediation analysis is an important first step in showing the different ways complex interventions such as collaborative care may exert their effects on patient-level outcomes. Our study adds to the CC and OAUD treatment literature by demonstrating that in this study, and for the entire sample, CC influenced abstinence through an increase in treatment initiation. This is important because there is growing evidence that integrated medical and SUD care compared with non-integrated care improves outcomes for people with SUDs and is cost-effective (Savic et al., 2017). Understanding how and why CC exerts its effects is important for efforts to refine and improve CC models of care.

It is unclear why treatment initiation, but not treatment engagement, mediates the effect of the CC intervention in the entire sample. Our larger study demonstrated that CC for OAUD in primary care leads to both improved treatment utilization and abstinence (Watkins et al., 2017b); the current study emphasizes the importance of returning for the first visit after identification, when patients are given feedback about their substance use and may initiate treatment with either BT or MAT. This suggests that improved patient outcomes may be less about how much treatment patients receive (as measured by treatment engagement), and more about the importance of initiating treatment early after identification. Future research should examine patient and provider factors associated with OAUD treatment initiation. In this regard, the Andersen model of the determinants of treatment utilization (Andersen and Newman, 1973) may provide a useful framework, with its conceptualization of predisposing patient characteristics; enabling factors, such as patient resources and illness severity; and characteristics of the healthcare organization as being important contributors to treatment utilization (Dhingra et al., 2010; Satre et al., 2003).

Our study also suggests that CC may work to improve abstinence through unidentified mechanisms. The CC intervention in this study was a complex, multifaceted intervention and included outreach and motivational interviewing by a care coordinator, population-based management and a warm handoff between the medical team and the behavioral health staff. It is possible that one of these other components was an "active ingredient" in how CC worked. Additional analyses have found that MI fidelity in the behavioral treatment was not associated with treatment engagement (Osilla et al., 2018). More research is needed to disentangle the effective components of the CC model.

The results of the mediation analysis on the two participant subgroups, even though on small sample sizes, sheds additional light on the results above, and suggest that CC may work differently for individuals with an alcohol disorder versus comorbid alcohol and opioid use disorders. Almost all individuals with opioid use disorder also had a comorbidity of alcohol use disorder. In the effect decomposition analyses, the total effect is the sum of the mediated and the direct effect, with the direct effects capturing the effect of the CC intervention on abstinence that is not attributable to treatment initiation or engagement. Within the group with an alcohol use disorder only, the estimated direct effects were consistently large and significant, suggesting that for AUD patients, the mechanism by which CC impacts abstinence is not necessarily due to increased initiation and engagement, but rather to some unmeasured factor. Within the alcohol and opioid comorbidity group, the mediated effect, while not statistically significant (at a 0.05 significance level), showed the possibility of total engagement mediation where it accounts for almost all of the total effect. Taken together, the effect decomposition analyses suggest that the effect of CC in the alcohol only group is driven by factors beyond initiation and engagement, while within the alcohol and opioid comorbid group, the effect on abstinence may be driven by engagement as a mechanism of the intervention. A study with a larger sample size is needed to confirm this interpretation and inference on opioid only disorders patients.

Our study has several limitations that should be considered when interpreting its results. First, the study took place at two sites of a single FQHC with an integrated behavioral health program. Thus, results may not generalize to settings without fully integrated behavioral health. In addition, with only 68% (258 out of 377) of enrolled patients participating at follow up and being included in the analytic sample, any systematic bias in the self-selection to participate can also result in a limitation of the generalizability of the results, especially that the non-used data is potentially not missing at random. Our study did not have the power to detect differences between the initiation of either brief therapy or pharmacotherapy; thus, we are not able to determine whether the type of treatment matters. Future research should examine this issue. Our primary outcome, abstinence, was assessed by self-report, as biological tests were inadequate for detecting 30-day opioid and alcohol use. Although we used validated tools, social desirability bias may have influenced CC participants to report abstinence more than participants receiving usual care. Moreover, we had differential retention, and it is possible that individuals lost to follow-up may have had worse outcomes than those for whom we have outcome data. Sample size limited our ability to examine whether diagnosis influenced how CC impacted outcomes, or whether the type of treatment (brief therapy vs. MAT) mattered. Future research should examine these issues.

5. Conclusions

Despite these limitations, this research sheds light on how CC may work to increase abstinence in a sample of primary care patients with OAUD. The current study emphasizes the importance of returning for the first visit after an OAUD be identified, when patients undergo an additional assessment, are given feedback about their substance use and may initiate treatment with either BT or MAT. Future research should examine whether a CC model of care is differentially effective for people with different types of substance use disorders.

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Fig. 1. Mediation analysis model. The letters λ , α and β represent linkages among variables.

Table 1

Characteristics of participants enrolled in the SUMMIT trial, overall and stratified by diagnostic group.

	Overall (N = 258)	Alcohol Only (N = 79)		Alcohol & Opioid (N = 55)		P
		CC	UC	CC	UC	
Baseline Characteristics						
Age, mean (SD)	42.1 (12.1)	42.4 (12.0)	44.8 (11.9)	38.8 (11.7)	41.7 (12.4)	0.05
Female, % (N)	24.0 (62)	25.3 (20)	32.9 (23)	16.4 (9)	16.0 (8)	0.08
Race, % (N)						
White	41.1 (106)	30.4 (24)	38.6 (27)	45.5 (25)	52.0 (26)	0.06
Black	16.7 (43)	16.5 (13)	24.3 (17)	10.9 (6)	14.0 (7)	
Multiple	13.2 (34)	16.5 (13)	5.7 (4)	20.0 (11)	12.0 (6)	
Other	29.1 (75)	36.7 (29)	31.4 (22)	23.6 (13)	22.0 (11)	
Initiation, % (N)	27.5 (71)	36.7 (29)	10.0 (7)	36.4 (20)	26.0 (13)	0.00
Engagement, % (N)	14.7 (38)	17.7 (14)	7.1 (5)	23.6 (13)	8.0 (4)	0.03

Note: Alcohol = Alcohol only group, Alcohol & Opioid = patients with both Alcohol and Opioids conditions, CC = Collaborative Care Intervention, UC = Usual Care Intervention; *p*-value compares the diagnoses by study condition groups. Only 4 participants had opioid only condition and were included in the overall estimates but excluded from the subgroup comparisons.

Table 2

Results of Logistic Regression Outcome and Mediation Models Testing the Use of any Evidence-Based OAUD Treatment Initiation as a Mediator of the Relationship between Collaborative Care Intervention and Abstinence.

	Outcome model				Mediator model			
	Estimate	SE	Wald χ^2	p	Estimate	SE	t	p
Overall Sample Analysis								
<i>Predictors</i>								
Hypothesized mediator: Initiation	1.21	0.34	3.55	< 0.001	Hypothesized mediator: Initiation			
Collaborative Care	0.48	0.32	1.50	0.13	1.04	0.34	3.08	< 0.01
<i>Predictors</i>								
Hypothesized mediator: Engagement	0.40	0.44	0.90	0.37	Hypothesized mediator: Engagement			
Collaborative Care	0.62	0.32	1.94	0.05	2.04	0.59	3.46	< 0.001
Alcohol Only Subgroup Analysis								
<i>Predictors</i>								
Hypothesized mediator: Initiation	0.21	0.60	0.34	0.73	Hypothesized mediator: Initiation			
Collaborative Care	1.19	0.57	2.09	0.04	2.45	0.75	3.25	< 0.001
<i>Predictors</i>								
Hypothesized mediator: Engagement	-0.33	0.76	-0.44	0.66	Hypothesized mediator: Engagement			
Collaborative Care	1.32	0.54	2.42	0.02	2.25	1.06	2.12	0.03
Alcohol and Opioid Subgroup Analysis								
<i>Predictors</i>								
Hypothesized mediator: Initiation	1.99	0.50	3.99	< 0.001	Hypothesized mediator: Initiation			
Collaborative Care	0.04	0.45	0.08	0.94	0.56	0.41	1.36	0.173
<i>Predictors</i>								
Hypothesized mediator: Engagement	0.93	0.60	1.56	0.118	Hypothesized mediator: Engagement			
Collaborative Care	0.00	0.44	0.01	0.992	2.29	0.78	2.93	< 0.01

Note: All models controlled for covariates including site, participant age, race, ethnicity and the receipt of professional substance abuse treatment in the past 12 months.

Table 3
Causal Effect Decomposition of the Relationship between Collaborative Care Intervention and abstinence outcomes.

Effect Type	Effect Decomposition			Alcohol only group (N = 149)			Alcohol & Opioid group (N = 105)		
	Overall Sample (N = 258)			Effect (95% CI)	p-value		Effect (95% CI)	p-value	
Hypothesized mediator: Initiation									
Total effect	11.7% (0.9%, 22.3%)	0.03		19.4% (3.7%, 34.0%)	0.02		3.7% (-11.6%, 18.2%)		0.61
Average causal mediated effect	3.8% (0.4%, 8.3%)	0.02		1.2% (-4.4%, 7.9%)	0.72		3.3% (-3.8%, 11.0%)		0.36
Average causal direct effect	7.9% (-2.7%, 18.2%)	0.14		18.3% (1.2%, 33.9%)	0.03		0.5% (-13%, 13.5%)		0.94
Hypothesized mediator: Engagement									
Total effect	11.9% (1.3%, 22.2%)	0.03		19.7% (4.3%, 34.2%)	0.01		3.2% (-10.9%, 17.0%)		0.64
Average causal mediated effect	1.2% (-1.3%, 4.7%)	0.37		-0.6% (-4.6%, 3.6%)	0.69		3.2% (-0.8%, 9.6%)		0.13
Average causal direct effect	10.7% (-0.1%, 21.2%)	0.05		20.3% (4.7%, 34.9%)	0.01		0% (-14.3%, 14.0%)		0.99

Note: All models controlled for covariates including site, participant age, race, ethnicity and the receipt of professional substance abuse treatment in the past 12 months.