QUALITY AND ACCESS OF BUPRENORPHINE TREATMENT FOR OPIOID USE DISORDER IN MEDICAID

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ABSTRACT

Alex K. Gertner: Quality and Access of Buprenorphine Treatment for Opioid Use Disorder in Medicaid
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The United States is in the midst of a drug overdose epidemic that shows no sign of abating. Studies suggest the rate of overdose deaths among Medicaid enrollees is several times higher than the general population rate. Given the continuing overdose epidemic and the elevated overdose risk among Medicaid beneficiaries, and the importance of Medicaid in financing substance use disorder services, there is a need for research on access and quality of opioid use disorder (OUD) treatment in Medicaid. Treatment with the medications buprenorphine or methadone, known as opioid agonist treatment (OAT), has the strongest evidence of reducing overdose mortality from OUD. Nevertheless, these medications are vastly underutilized in practice. This dissertation consists of three chapters that provide evidence for improving access and quality of buprenorphine treatment for OUD in Medicaid. The first chapter uses national data to examine whether Medicaid expansion under the Affordable Care Act increased use of OAT. Many health policy professionals have pointed to the potential of Medicaid expansion for increasing access to OUD treatment, but studies have yet to demonstrate this. This chapter also examines whether limits in the number of OAT providers in states limited the effect of expansion on OAT use. The second chapter examines whether improvements in buprenorphine treatment access may be coming at the cost of quality using data from North Carolina Medicaid. Many states, including North Carolina, have sought to increase access to OAT by encouraging non-

specialist primary care providers (PCPs) to deliver buprenorphine treatment. However, some providers and political leaders have raised concerns that PCPs do not have the training or resources to provide high-quality buprenorphine treatment. This chapter provides the first evidence of whether this is the case. The third chapter combines analyses of North Carolina Medicaid claims and interviews with buprenorphine prescribers to understand factors that drive retention in treatment. Treatment guidelines generally recommend patients receive OAT for at least 6 months, but many patients drop out of treatment sooner. This chapter developed a novel mixed-methods approach to identify provider-level practices that could improve retention in treatment while controlling for differences in patient characteristics between providers.

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TABLE OF CONTENTS

LIST OF TABLES ix

LIST OF FIGURES x

LIST OF ABBREVIATIONS xi

INTRODUCTION 1

CHAPTER 1: THE EFFECT OF MEDICAID EXPANSION ON USE OF OPIOID AGONIST TREATMENT AND THE ROLE OF PROVIDER CAPACITY CONSTRAINTS 7

Introduction 7

Methods 9

Measures of OAT Utilizations 9

Measures of Medicaid Expansion 10

Measures of Capacity 11

Statistical Analyses 12

Results 14

Effect of Expansion on Methadone Dispensed 14

Effect of Medicaid Expansion on Buprenorphine Dispensed 15

Discussion 16

CHAPTER 2: IMPROVEMENTS IN QUALITY OF BUPRENORPHINE TREATMENT AND DIFFERENCES BY PROVIDER CHARACTERISTICS IN NORTH CAROLINA MEDICAID 28

Introduction 28

Methods 30

Conceptual Model 30
Data 30
OUD Diagnosis and Treatment 31
Quality Measures 31
Provider Characteristics 32
Statistical Analysis 34
Results 35
Discussion 37
CHAPTER 3: A MIXED METHODS STUDY OF PROVIDER-LEVEL DIFFERENCES IN BUPRENORPHINE TREATMENT RETENTION FOR OPIOID USE DISORDER 47
Introduction 47
Methods 48
Data 49
Buprenorphine Treatment and Retention 49
Patient and Provider Characteristics 50
Statistical Analysis 51
Provider Interviews 51
Results 54
Characteristics Associated with Retention 54
Treatment Experience and Services 55
Clinical Practices 57
Attitudes and Experiences 60
Discussion 62
CONCLUSION 71
APPENDIX 1: CPT CODES AND PRESCRIBER CHARACTERISTICS 75

APPENDIX 2: CODES 77

APPENDIX 3: INTERVIEW GUIDE 78

REFERENCES 80

LIST OF TABLES

Table 1. Effect of Medicaid Expansion on Methadone Kilograms Dispensed in States by OTP Concentration and Medicaid Acceptance 21

Table 2. Effect of Medicaid Expansion on Buprenorphine Kilograms Dispensed in States by Waiver Concentration and Physician Medicaid Acceptance 23

Supplemental Table 1. Sensitivity Analyses of the Effect of Medicaid Expansion on Methadone Use 25

Supplemental Table 2. Sensitivity Analyses of the Effect of Medicaid Expansion on Buprenorphine Use 26

Supplemental Table 3. Summary of Measures of OAT Provider Capacity 27

Table 3. Unadjusted Percent of Treatment Episodes Achieving Quality Measures by Provider Specialty 43

Table 4. Association Between Prescriber Characteristics and Quality Measures in Buprenorphine Treatment Episodes 44

Table 5. Patient, Provider and Treatment Episode Characteristics by 180-Day Retention 65

Table 6. Association of Patient and Provider Characteristics with 180-Day Retention 67

Table 7. Patient Characteristics of Matched High- and Low-Retention Providers 69

Table A1. CPT Codes for North Carolina Medicaid Services 75

Table A2. Buprenorphine Prescriber Characteristics by Specialty 76

LIST OF FIGURES

Figure 1. Trends in Methadone and Buprenorphine Dispensed in Medicaid Expansion and Non-Expansion States per Capita 20

Figure 2. Yearly OUD Prevalence and OAT Receipt in NC Medicaid 41

Figure 3. Percent of Buprenorphine Treatment Episodes Achieving Quality Measures by Year 42

LIST OF ABBREVIATIONS

BH	behavioral health
FQHC	federally qualified health center
OAT	opioid agonist treatment
OTP	opioid treatment program
OUD	opioid use disorder
PCMH	patient-centered medical home
PCP	primary care provider
SUD	substance use disorder

INTRODUCTION

The United States is in the midst of a drug overdose epidemic that shows no sign of abating.[1] More Americans now die of drug overdoses than died of AIDS at the height of the HIV epidemic.[2] Deaths from opioid overdoses are largely driving this crisis. Approximately 49,000 Americans died from opioid-involved overdoses in 2017, a 11% increase from 2016.[3] More than 13,000 North Carolinians died from opioid-involved overdoses between 2006 and 2017.[4]

State-level studies suggest the rate of overdose deaths among Medicaid enrollees is several times higher than the general population rate.[5,6] A North Carolina study found the unintentional overdose death rate in Medicaid was 3.5 times higher than the state rate.[6] Medicaid alone accounts for over 20% of all spending on substance use disorder (SUD) services.[7] Given the continuing overdose epidemic, the elevated overdose risk among Medicaid beneficiaries, and the importance of Medicaid in financing substance use services, there is a need for research on access and quality of opioid use disorder (OUD) treatment in Medicaid.

Opioid agonist treatment (OAT) with buprenorphine or methadone is effective at reducing illicit opioid use among people with OUD.[8] Nevertheless, these medications are vastly underutilized,[9] including in Medicaid. In an analysis of Medicaid claims data, 63% of new treatment episodes for OUD did not involve OAT.[10] Buprenorphine is the most promising medication for expanding access to treatment. Federal law imposes strict limits on dispensation of methadone in registered opioid treatment programs (OTPs).[11] By contrast, providers can obtain waivers to prescribe buprenorphine in office-based settings.[11] Initial waivers allow

providers to treat up to 30 patients, with the possibility of expanding to 100 patients and then to 275 patients.[12]

This dissertation consists of three chapters that provide evidence to inform policies for improving access and quality of buprenorphine treatment for OUD:

- The first chapter uses national data to examine whether Medicaid expansion increased use of OAT in states that expanded Medicaid. Many health policy professionals have pointed to the potential of Medicaid expansion for increasing access to OUD treatment.[13] This chapter also examines whether limits in the number of OAT providers in states limited the effect of expansion on use of these medications.
- The second chapter examines whether improvements in buprenorphine treatment access may be coming at the cost of quality using data from North Carolina Medicaid. Some providers and political leaders have raised concerns that efforts to expand access to office-based buprenorphine treatment, particularly by primary care providers (PCPs), are coming at the cost of treatment quality.[14,15] This chapter provides the first evidence of whether this is the case.
- The third chapter combines analyses of North Carolina Medicaid data and interviews with North Carolina buprenorphine prescribers to understand factors that drive retention in buprenorphine treatment. Despite evidence that retention in buprenorphine treatment is associated with lower all-cause and overdose mortality,[16] buprenorphine retention rates remain highly variable in practice.[17] This chapter provides crucial information that can be used to improve treatment retention. This chapter also develops a novel mixed-methods approach for examining differences in provider-level treatment outcomes while controlling for differences in patient characteristics between providers.

Chapter 1: The Effect of Medicaid Expansion on Use of Opioid Agonist Treatment and the Role of Provider Capacity Constraints

The Affordable Care Act (ACA) was expected to increase use of SUD treatment services, in part through Medicaid expansion.[18–20] Nevertheless, the effect of Medicaid expansion on OAT use remains unknown. Low rates of OAT providers and low Medicaid acceptance among OAT providers may have limited Medicaid expansion's effect on OAT use. Evidence suggests nearly all states lack enough OTPs and buprenorphine-waivered physicians to provide OAT to all individuals in need.[21] This shortage is exacerbated by the fact that only approximately half of buprenorphine prescribers accept Medicaid for office visits.[22]

The objective of this chapter was to assess the effect of Medicaid expansion on OAT use across payers and treatment sources using data from all states where Medicaid covered these treatments prior to expansion. This chapter was informed by economic theory. We hypothesized that Medicaid expansion would increase OAT use by lowering the cost of OAT for people newly eligible for Medicaid. An additional objective was to examine whether there was variation in the effect of Medicaid expansion on OAT use by provider concentration and the percent of providers who accept Medicaid. We hypothesized that OAT use would not increase in expansion states with the lowest concentration of providers and percent of providers accepting Medicaid.

We used advanced econometric methods to model the effect of Medicaid expansion on buprenorphine and methadone dispensed in expansion and non-expansion states. We ran difference-in-differences (DID) models with state and year fixed effects to control for time trends and time-invariant state-level differences. We also included in models time-varying state population, poverty rate, and unemployment rate. We did not find evidence that expansion increased methadone dispensed in states. We believe this lack of effect may result from the extremely constrained number of OTPs even in states with the most OTPs. We found evidence

that expansion only increased buprenorphine dispensed in states with the most buprenorphine-waivered providers. This chapter provides the first evidence that Medicaid expansion increased overall buprenorphine dispensed in states, but that constrained provider supply limited the effect of expansion. States must pursue policies to increase OAT provider supply for increases in insurance coverage to translate to increases in treatment use.

Chapter 2: Improvements in Quality of Buprenorphine Treatment and Differences by Provider Characteristics in North Carolina Medicaid

In response to high rates of opioid overdose deaths, states have been working to increase access to OAT.[23] Many of these efforts have focused on expanding office-based OAT by mobilizing providers, especially PCPs, to offer buprenorphine treatment.[24,25] Some providers and political leaders have raised concerns that PCPs and office-based providers do not have the training or resources to provide high-quality treatment for OUD.[14,15] Nevertheless, no study has examined quality of buprenorphine treatment over time or investigated differences in quality by provider characteristics such as specialty.

This chapter was guided by the interdisciplinary conceptual framework for physician compliance with evidence-based guidelines.[26] We used North Carolina Medicaid claims data to measure buprenorphine treatment quality in two ways. Firstly, we examined 180-day retention in buprenorphine treatment, a measure of quality endorsed by the National Qualify Forum.[27] We also measured quality as adherence to American Society of Addiction Medicine (ASAM) treatment guidelines.[28] We identified eight recommended practices from ASAM guidelines: visit frequency, toxicological testing frequency, behavioral health service use, HIV testing, HCV testing, naloxone prescription, opioid prescription, and benzodiazepine prescription.

We found that while the number of NC Medicaid enrollees receiving OAT increased from 2014 to 2017, the percent of enrollees with OUD who received OAT remained low,

suggesting demand for treatment outstripped supply. Quality of treatment improved across all measures even as the number of people receiving OAT increased. PCPs provided care that was of comparable or higher quality than other providers. We found no evidence to support concerns that increased access to office-based buprenorphine treatment is reducing quality. These results support continuing efforts to increase access to this form of treatment.

Chapter 3: A mixed methods study of provider-level differences in buprenorphine treatment retention for opioid use disorder

A persistent challenge in the delivery of buprenorphine treatment for OUD is low treatment retention. Despite evidence that retention in buprenorphine treatment is associated with lower all-cause and overdose mortality,[16] buprenorphine retention rates remain highly variable in practice.[17] Even though there is growing recognition of importance of retention in buprenorphine treatment,[29,30] there is little research on why patients stop treatment. Some have suggested that burdensome and restrictive treatment practices, such as requiring patients to engage in counseling and discharging patients for drug use, could be driving low retention.[31,32]

The goal of this study was to investigate factors driving differences in retention between providers while accounting for differences in patient characteristics. We conducted a mixed methods study using North Carolina Medicaid claims data and interviews with providers. We used Medicaid claims to identify patient and provider characteristics associated with retention in treatment. Using a purposeful sampling approach, we then selected sub-groups of high- and low-retention providers whose patients had similar characteristics, in order to ensure that differences in retention weren't driven by observable patient characteristics.[33] We interviewed providers from these groups about their treatment practices, resources, and attitudes that could affect retention. We used Simpson's conceptual framework for drug treatment process and outcomes to inform selection of variables from claims and development of the interview guide.[34]

We found that high-retention providers used more flexible and less restrictive treatment approaches as compared with low-retention providers. We did not find evidence that providers who achieved higher retention consistently did so by providing more comprehensive services, delivering lower-cost care, or selecting for more stable patients. We also found large differences in retention by race and ethnicity. These differences could be driven by barriers to retention noted by providers such as treatment cost, transportation, and stigma. Our results suggest adopting less restrict treatment approaches could be improve retention in buprenorphine treatment. More research on patient perspectives and experiences in treatment are needed to understand racial and ethnic disparities in retention.

CHAPTER 1: THE EFFECT OF MEDICAID EXPANSION ON USE OF OPIOID AGONIST TREATMENT AND THE ROLE OF PROVIDER CAPACITY CONSTRAINTS

Introduction

The drug overdose crisis in the United States continues to worsen. In 2017 there were over 70,000 deaths from drug overdoses, a 9% increase over the year before.[3] More than two thirds of these overdose deaths involved opioids, pointing to the importance of reducing harm from opioid use in addressing the overdose crisis. Opioid agonist treatment (OAT) with buprenorphine or methadone is effective at reducing illicit opioid use among people with opioid use disorder (OUD).[8] Nevertheless, these medications are vastly underutilized.[9] In an analysis of Medicaid claims data, 63% of new treatment episodes for OUD did not involve OAT.[10]

The Affordable Care Act (ACA) was expected to increase use of substance use disorder (SUD) treatment services, in part through Medicaid expansion.[18–20] However, the available evidence to date suggests that the ACA Medicaid expansion did not increase self-reported treatment rates for SUD.[35] The apparent lack of effect of Medicaid expansion on SUD treatment rates is puzzling given research findings that the ACA has resulted in higher rates of insurance among people with SUD,[35,36] that the ACA resulted in increased SUD benefits under Medicaid plans,[37] and that Medicaid expansion increased other forms of healthcare utilization.[38]

The effect of Medicaid expansion on overall OAT utilization remains unknown. Recent studies have found that Medicaid expansion increased Medicaid-funded buprenorphine by at least 70%.[39–41] However, Medicaid expansion may not have increased overall use of OAT if

individuals newly accessing OAT through Medicaid were previously accessing OAT through other sources of payment, such as private insurance, block grants, or self-pay. Indeed, there is evidence that the number of privately-insured individuals using buprenorphine plateaued between 2013-2015,[42] which could be explained by individuals switching to other payer sources.

A possible reason that Medicaid expansion has not increased SUD treatment rates is that there are not enough SUD treatment providers or enough providers who accept Medicaid to meet the demand for treatment. When it comes to OAT, treatment can be provided through opioid-treatment programs (OTPs) or office-based providers.[11] OTPs are strictly-regulated programs permitted to dispense methadone and buprenorphine for treatment of OUD.[11] Buprenorphine, but not methadone, can also be prescribed by office-based providers who obtain a waiver of DEA restrictions to prescribe buprenorphine.[11] Evidence suggests nearly all states lack enough OTPs and waivered physicians to provide OAT to all individuals in need.[21] This shortage is exacerbated by the fact that only approximately half of buprenorphine prescribers report accepting Medicaid for office visits.[22]

Two studies have provided a partial picture of the effect of Medicaid expansion on overall OAT use. Meinhofer and Witman found that Medicaid expansion increased OAT use from OTPs by about 30% in states where Medicaid covered buprenorphine and methadone.[40] While this finding is encouraging, OTPs account for a minority of OAT treatment. As of 2012, the treatment capacity of office-based buprenorphine providers was 3.5 times larger than the number of people receiving methadone in OTPs.[21] Saloner and colleagues found in a sample of five states that states that expanded Medicaid had higher rates of buprenorphine prescription fills per person after expansion relative to non-expansion states controlling for the insurance rate in states.[43] However, the authors also found that expansion did not affect the number of days with

buprenorphine fills per person. No study has examined the effect of Medicaid expansion on overall OAT across payers in all states.

The objective of this study was to assess the effect of Medicaid expansion on OAT use across payers and treatment sources using data from all states where Medicaid covered these treatments prior to expansion. We hypothesized that Medicaid expansion would increase OAT use by lowering the cost of OAT for people with OUD newly eligible for Medicaid. An additional objective was to examine whether there was variation in the effect of Medicaid expansion on OAT use by provider concentration and the percent of providers who accept Medicaid. We hypothesized that OAT use would not increase in expansion states with the lowest concentration of providers and percent of providers accepting Medicaid.

Methods

Measures of OAT Utilizations

We conducted a retrospective panel data study using a difference-in-differences (DID) approach to examine the causal effect of Medicaid expansion on OAT utilization. The dependent variables in our analyses were the kilograms of methadone and buprenorphine dispensed in each state annually. At a typical dose of 100 mg a day, an additional kilogram of methadone dispensed can treat about 27 individuals for a year. At a typical dose of 16 mg a day, an additional kilogram of buprenorphine can treatment about 625 people for a year. We obtained yearly data from the Drug Enforcement Administration's Automation of Reports and Consolidated Orders System (ARCOS) for 2006-2017. ARCOS contains data on opioids dispensed from all sources and across payers. We included only methadone dispensed from OTPs. We included buprenorphine dispensed from OTPs and pharmacies.

As of 2017, 33 states had adopted ACA Medicaid expansion. In 26 of these states, the ACA Medicaid expansion became effective in January 2014 ,[44] though five of these states began

gradual expansions prior to 2014.[45] In the remaining seven states, two expanded later in 2014, three expanded in 2015, and two expanded in 2016. We included in our main methadone analysis 28 states whose Medicaid programs reported covering methadone as of 2007.[46] Of these 28 states, 19 expanded Medicaid. We similarly included in our main analyses of buprenorphine 45 states whose Medicaid programs reported covering buprenorphine as of 2007.[46] Of these 45, 29 expanded Medicaid. In sensitivity analyses, we include states who covered methadone (31 states) or buprenorphine (50 states) by 2013.

The ARCOS data do not allow us to distinguish between buprenorphine formulations approved for OUD treatment and those approved for pain treatment. Following Wen and colleagues' approach,[39] we used the Medicaid State Drug Utilization data to find that more than 99.6% of Medicaid-funded buprenorphine units were for OUD rather than pain between 2010 and 2017. We therefore believe that buprenorphine formulations for pain account for a very small percentage of buprenorphine and are unlikely to significantly bias our findings.

Measures of Medicaid Expansion

The main independent variable in our analyses is an indicator variable of whether states had expanded Medicaid at any time during the year.[44] We conducted sensitivity analyses that excluded states that partially expanded Medicaid before 2014 (leaving 23 methadone and 40 buprenorphine states),[45] excluded states that expanded Medicaid after 2014 (leaving 27 methadone and 41 buprenorphine states), and excluded states that expanded Medicaid through 1115 waivers (leaving 25 methadone and 38 buprenorphine states). The effect of expansion on OAT use in these states may have differed because of more gradual or limited increases in Medicaid enrollment resulting from early, late or partial expansion. We also conducted sensitivity analyses controlling for enactment and mandated use of prescription drug monitoring programs (PDMPs) following the approach of Meinhofer and Witman.[40]

The primary mechanism by which Medicaid expansion may have increased OAT use is by increasing Medicaid enrollment particularly among previously uninsured individuals. However, the extent to which Medicaid expansion increased Medicaid enrollment levels and overall insurance rates varied between states.[47] Even states that did not expand Medicaid saw increases in Medicaid enrollment and increases in insurance rates after 2014 because of the woodwork effect and other ACA provisions.[47] As a check on our main results, then, we also considered models where the independent variables were the number of people enrolled in Medicaid[48,49] or the annual health insurance rate in each state for those under 65, including public and private coverage sources.[50] These models provide estimates of the overall association between our outcomes and changes in Medicaid enrollment and the health insurance rate in our study period. We do not include an indicator for Medicaid expansion in these models, since they are directly estimating an association between enrollment and insurance rate over time.

Measures of Capacity

We used measures of OAT provider capacity from years prior to 2014 because we were interested in the effect of expansion on OAT use based on states' supply of OAT prior to expansion. We used the concentration of OTPs per population in each state in 2013 as a measure of the methadone capacity in states. We obtained the number of OTPs from the National Survey of Substance Abuse Treatment Services (NSSATS).[51] We found that the number of OTPs in a state had a Pearson's correlation 0.97 with the number of outpatients receiving methadone reported in NSSATS, suggesting this is a good measure of treatment capacity.

We used the concentration of buprenorphine waivered providers per population in states in 2013 as the measure of buprenorphine capacity. We obtained the yearly number of new buprenorphine waivers by state from the Substance Abuse and Mental Health Services Administration through a Freedom of Information Act request. The number of active waivers in

each state in each year was not available. We summed the number of new waivers in each year prior to 2013 to obtain an estimate of the number of active waivers in each state in 2013. This approach likely produced an overestimate of the number of waivers in a state. However, since we used this measure simply to separate states into those with more and fewer waivers, the overestimate likely did not bias our results. As an additional sensitivity analysis, we used the concentration of buprenorphine providers with 100 and 275 patient waivers in states in 2013 as the measure of buprenorphine capacity. This approach may better capture waivered providers who are actively prescribing buprenorphine.

The effect of Medicaid expansion may rely not only on there being enough OAT providers in states but enough OAT providers who accept Medicaid. Therefore, we also divided states into thirds by the percent of OAT providers accepting Medicaid. We obtained the percent of OTPs that reported accepting Medicaid in each state in 2013 from the National Survey of Substance Abuse Treatment Services.[51] There is no data source for how many buprenorphine-waivered providers accept Medicaid in each state. As a proxy, we used the overall percentage of physicians who report accepting Medicaid in each state from the 2011 National Ambulatory Medical Care Survey Electronic Medical Records Supplement.[52] The percent of buprenorphine prescribers who accept Medicaid likely differs from the overall percent of physicians accepting Medicaid in a state. However, as long as states with the fewest overall physician Medicaid acceptance are the same as states with the fewest buprenorphine prescriber Medicaid acceptance, our analysis is unlikely to be biased. Capacity measures are summarized in Supplemental Table 3.

Statistical Analyses

We employed a DID approach using two-way fixed effects models. We used year fixed effects to non-parametrically account for trends in methadone and buprenorphine dispensed in

states. We used state fixed effects to account for time-invariant differences between states. To account for within-state confounding, we controlled for yearly state unemployment[53] and state poverty rates.[50] We also included in our models annual state population. This approach more flexibly controls for the effect of population compared to using population as the denominator of our outcomes. We present ordinary least squares (OLS) coefficients with standard errors clustered at the state level.

We tested the DID parallel trends assumption by running models on pre-2014 data (prior to Medicaid expansion) and checking whether expansion states had a different time slope in OAT use than non-expansion states by interacting the overall time trend with an expansion indicator. The interaction term was not statistically significantly different from zero for methadone (-0.93, 95% CI: -11 to 8.7) or buprenorphine (1.2, 95% CI: -1.6 to 4.0). Therefore, we were unable to reject the hypothesis that there was no difference in the pre-2014 trends between expansion and non-expansions, supporting the use of the DID approach.

To determine whether the effect of expansion differed in states by provider capacity, we divided states into thirds by measures of provider capacity, creating indicators for which tercile each state was in. We then ran models where we interacted these indicators with the Medicaid expansion indicator. These models produced an estimate of the effect of Medicaid expansion in the lowest tercile states and estimates of interaction terms test the difference in the effect of Medicaid expansion from the lowest tercile states with the top two tercile states. If provider capacity limited the effect of Medicaid expansion, states with fewer OAT providers would not experience increases in buprenorphine and methadone after expansion. On the other hand, if states were able to expand their supply of OAT providers to meet increased demand that resulted

from Medicaid expansion, we would expect to see a positive effect of expansion even in states that had low levels of OAT providers prior to expansion.

One possibility is that provider capacity prior to expansion was correlated with treatment need. That is, states with more OTPs and waivered providers may also be the ones with higher OUD rates and overdose deaths rates. We found that the Pearson's correlation between OTP per capita and opioid overdose mortality in 2013 was 0.47, and the Pearson's correlation between buprenorphine waivers per capita and overdose mortality in 2013 was 0.37, suggesting a moderate level of correlation between treatment capacity and opioid overdose deaths. We conducted a sensitivity analysis examining differences in the effect of Medicaid expansion by the tercile of opioid overdose death in 2013.

As described above, we conducted sensitivity analyses of our main models that involved excluding states that expanded Medicaid before 2014 (early expansion), expanded Medicaid after 2014 (late expansion), and expanded Medicaid through 1115 waivers. We also conducted sensitivity analyses where we included states whose Medicaid programs covered methadone and buprenorphine as of 2013 rather than 2007. In addition, we tested controlling for the implementation and mandated use of PDMPs. Finally, we conducted a sensitivity analysis where we used the concentration of buprenorphine providers with 100 and 275 patient waivers in states in 2013 as the measure of buprenorphine capacity.

Results

Effect of Expansion on Methadone Dispensed

Figure 1 presents the total unadjusted trends in buprenorphine and methadone kilograms per capita dispensed for expansion and non-expansion states. In adjusted analyses, we did not detect an average effect of Medicaid expansion on methadone dispensed among all states (Table 1 – column 1). We similarly did not find differences in the effect of Medicaid expansion by OTP

concentration or OTP Medicaid acceptance among states (Table 1 – columns 2-3). We also did not find an association between methadone dispensed and Medicaid enrollment or percent insured in states throughout the study period (Table 1 – columns 4-5), lending support to the finding of no effect of expansion on methadone dispensed. We similarly did not detect any effects of Medicaid expansion on methadone dispensed in our sensitivity analyses, which excluded states by expansion timing, 1115 waiver use, Medicaid OAT coverage, and controlled for PDMPs laws (Supplemental Table 1). While all sensitivity analyses of the effect of Medicaid expansion were null, point estimates of the effect of Medicaid expansion when removing early expansion states were notably smaller than estimates from other models.

Effect of Medicaid Expansion on Buprenorphine Dispensed

We did not find evidence of an average effect of Medicaid expansion on buprenorphine dispensed among all states (Table 2 – column 1). We also did not find an association between buprenorphine dispensed and Medicaid enrollment or percent insured among all states (Table 2 – columns 4-5), lending support to the finding that Medicaid expansion did not increase buprenorphine dispensed.

We did find that the effect of Medicaid expansion differed in the states with the most waivered providers compared to the states with the fewest waivered providers (Table 2 – column 2). In states with the most waivered providers, Medicaid expansion led to a yearly increase of 12 kilograms of buprenorphine dispensed. This increase is equivalent to a 33% increase in buprenorphine dispensed in a state-year and is enough to treat 7,500 patients at a daily dose of 16 mg. We did not find differences in expansion effect by physician Medicaid acceptance (Table 2 columns 3). Our sensitivity analyses results were consistent with the reported models in that expansion only increased buprenorphine dispensed in the states with the most waivered providers (Supplemental Table 2).

The states with the most waivered providers were very similar to the set of states with the most providers with 100 and 275 patient waivers, so dividing states by 100 and 275 patient waivers produced nearly identical estimates as stratifying by all waivers (results not presented). We similarly found no differences in the effect of Medicaid expansion by the tercile of opioid overdose death rate in 2013 (results not presented).

Discussion

We found that Medicaid expansion did not increase the amount of methadone dispensed in states that had Medicaid coverage of methadone. Among states where Medicaid covered buprenorphine, we found that Medicaid expansion increased buprenorphine dispensed only in states with the highest concentrations of providers waivered to prescribe buprenorphine. These results suggest capacity constraints limited the effect of Medicaid expansion on buprenorphine dispensed.

Our results suggest that the waiver requirement for buprenorphine prescriptions could be restricting access to OUD treatment expansion at a time of high and rising overdose deaths. This finding lends support to arguments for eliminating the waiver as a requirement of buprenorphine prescription. Critics of the waiver have argued that the waiver disrupts adoption of a safe and effective treatment that can be provided within the scope of usual primary care practice.[54] It is possible that without the waiver requirement in place, Medicaid expansion could have more broadly increased treatment access. That said, research shows numerous barriers to buprenorphine treatment implementation remain beyond the waiver requirement, such as prior authorization policies, low reimbursement, perceived lack of training, perceived lack of community psychosocial services, and more.[55–59] Addressing all of these barriers may be needed to substantially expand treatment access.

The lack of an average effect of Medicaid expansion on overall buprenorphine dispensed stands in contrast with findings that expansion substantially increased the amount of Medicaid-paid buprenorphine in expansion states.[39] In states where expansion did not increase the overall buprenorphine dispensed, it may have only shifted buprenorphine payment from non-Medicaid payers to Medicaid, as research suggests took place with SUD treatment overall.[35] Such a shift may have beneficial effects for individuals, whose out-of-pocket costs for treatment may have significantly decreased, providing more available income for other needs such as housing and food.

Our results with respect to methadone differ from those of Meinhofer and Witman who found that Medicaid expansion increased the amount of methadone dispensed in expansion states.[40] Our models differed from those of Meinhofer and Witman in that we included more years of data and more flexibly controlled for the effects of population changes on methadone dispensed. Our finding of no effect from expansion was supported by the lack of association between Medicaid enrollment and methadone dispensed during the study period.

A likely explanation for why Medicaid expansion did not increase methadone dispensed is that OTP capacity is highly constrained. There is evidence that the number of persons receiving methadone treatment remained relatively flat between 2003-2012, even as opioid overdose deaths were raising dramatically.[21] OTP expansion is likely limited by restrictive regulations[60] and lack of reimbursement for methadone treatment from private health plans.[61] Even if more OTPs opened in response to greater treatment demand, the highly regimented nature of methadone treatment under current regulations, wherein patients must visit clinics daily during working hours, makes methadone an unattractive option for many people with OUD.[62] Reforming the methadone regulatory regime to be in line with other high-income countries,

including by allowing office-based prescription of methadone for OUD, may be necessary for insurance gains to translate to greater methadone treatment access.[63]

The effect of expansion on methadone dispensed may also be gradual, possibly as OTP capacity slowly increases. Indeed, we found that removing early expansion states from our models decreased the point estimates of expansion's effect on methadone dispensed. This may suggest that early expansion states are inflating the main estimates, possibly because expansion did increase methadone dispensed in these states. That finding could mean more years of data are needed to detect effects of expansion on methadone dispensed in states that expanded in 2014. That said, excluding late expansion states from our models did not substantially increase our point estimates.

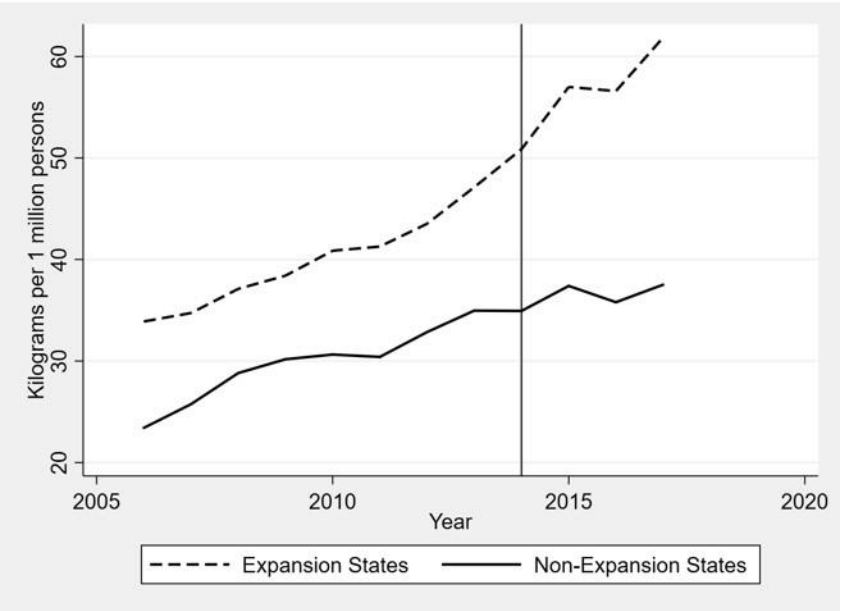
We did not find differences in the effect of Medicaid expansion by the percent of OTPs or physicians accepting Medicaid. However, these results should not be taken as definitive evidence that Medicaid acceptance is not a barrier to treatment expansion. In the lowest tercile of states by OTP Medicaid acceptance, only 43% of OTPs accepted Medicaid in 2013. Even in states where Medicaid covers methadone, Medicaid programs may employ low reimbursement rates and high administrative burdens that discourage OTPs from accepting Medicaid.[64] Our use of physician Medicaid acceptance may have been an imperfect proxy for buprenorphine provider Medicaid acceptance. Approximately half of buprenorphine prescribers in a national survey reported accepting Medicaid for office visits,[22] far below the reported average rates of physician Medicaid acceptance. Future studies should continue examining the role of Medicaid acceptance on OAT access, including policies to increased Medicaid acceptance. Evidence from Virginia suggests that increased Medicaid reimbursements for SUD services increased the number of buprenorphine prescribers billing Medicaid and the rate of OAT treatment among enrollees.[65]

Our analyses have limitations. Our data provide an all-payer source of OAT medication dispensed, but the data do not allow us to observe the number of individuals receiving OAT or examine the extent to which buprenorphine prescriptions were for off label uses. We were also unable to account for Medicaid policy changes, such as changes to prior authorization, since comprehensive longitudinal data on these variables is unavailable.

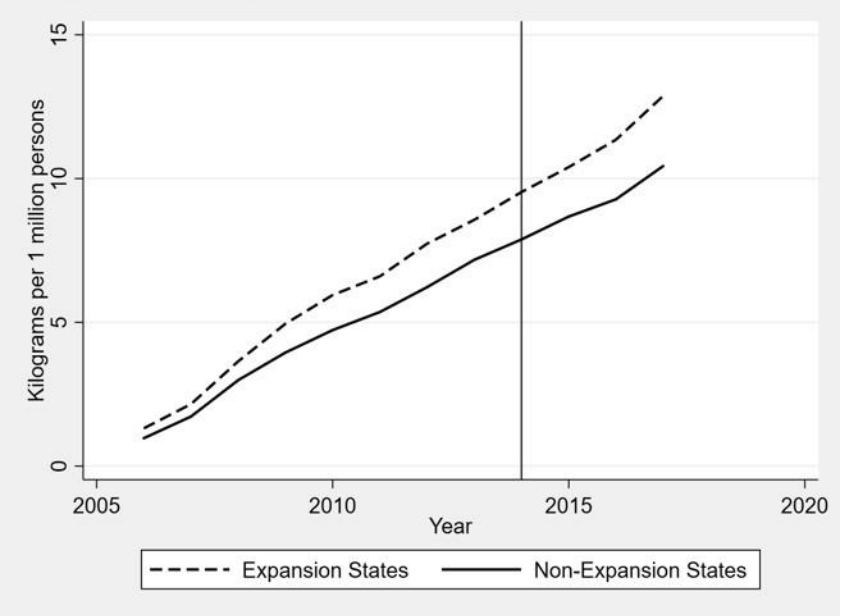
Our results should not be taken to mean that expanding insurance coverage is not important in increasing access to OAT, but that insurance expansion is likely not enough. These results point to the importance of increasing the capacity of OAT providers, particularly for buprenorphine prescribers.

Figure 1. Trends in Methadone and Buprenorphine Dispensed in Medicaid Expansion and Non-Expansion States per Capita

•Methadone dispensed from OTPs



•Buprenorphine dispensed from OTPs and pharmacies



The data presented are from the Drug Enforcement Administration's Automation of Reports and Consolidated Orders System (ARCOS) for 2006-2017. ARCOS contains data on opioids dispensed from all sources and across payers. We included only methadone dispensed from OTPs in 28 states where Medicaid covered methadone as of 2007. We included buprenorphine dispensed from OTPs and pharmacies in 45 states where Medicaid covered buprenorphine as of 2007.

Table 1. Effect of Medicaid Expansion on Methadone Kilograms Dispensed in States by OTP Concentration and Medicaid Acceptance

	1 Main model	2 OTP concentration interacted model[a]	3 OTP Medicaid acceptance interacted model[b]	4 Medicaid enrollment sensitivity model	5 Percent insured sensitivity
Medicaid expansion (average effect)	25.0 [-41.7,91.7]				
Medicaid expansion (bottom third)		14.9 [-42.1,71.8]	27.4 [-33.6,88.5]		
Expansion x middle third		34.5 [-43.9,112.9]	17.8 [-34.1,69.7]		
Expansion x top third		1.87 [-60.0,63.7]	-25.1 [-87.4,37.1]		
Unemployment (%)	1.00 [-15.8,17.8]	1.90 [-14.9,18.7]	1.56 [-14.8,17.9]	4.88 [-14.5,24.3]	0.065 [-19.1,19.3]
Population (10,000s)	0.066 [-1.03,1.16]	0.0025 [-1.10,1.11]	-0.0063 [-1.10,1.09]	-0.54 [-2.03,0.95]	0.037 [-1.19,1.27]
Poverty rate (%)	-2.52 [-21.4,16.4]	-4.30 [-25.9,17.3]	-1.09 [-19.0,16.9]	-2.83 [-20.1,14.4]	-0.33 [-16.0,15.4]
Medicaid enrollment (100,000s)				4.48 [-2.51,11.5]	
Insurance Rate (%)					-0.13 [-8.85,8.58]
State-years	336	336	336	336	336

95% confidence intervals in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[a] States are divided into thirds by the number of OTPs per 100,000 persons in 2013. Bottom third states (mean 0.24 OTPs per 100,000 persons, 6 expansion states, 4 non-expansion states): FL, HI, MI, MN, MO, OH, OR, VA, WA, WI. Middle third states (mean 0.45 OTPs per 100,000 persons, 5 expansion states, 4 non-expansion states): AL, AZ, CA, GA, NC, NJ, NV, PA, UT. Top third states (mean 0.93 OTPs per 100,000 persons, 8 expansion states, 1 non-expansion state): CT, DE, MA, MD, ME, NH, NY, RI, VT.

[b] States are divided into thirds by the percent of OTPs in the states accepting Medicaid in 2013. Bottom third states (41% OTPs accept Medicaid, 4 expansion states, 6 non-expansion states): AL, AZ, DE, FL, GA, MI, MN, MO, NC, VA. Middle third states (79% OTPs accept Medicaid, 7 expansion states, 2 non-expansion states): CA, MA, ME, NJ, OH, OR, PA, UT, WA. Top third states (98% OTPs accept Medicaid, 8 expansion states, 1 non-expansion states): CT, HI, MD, NH, NV, NY, RI, VT, WI.

Table 2. Effect of Medicaid Expansion on Buprenorphine Kilograms Dispensed in States by Waiver Concentration and Physician Medicaid Acceptance

	1 Main model	2 Waiver concentration interacted model[a]	3 Physician Medicaid acceptance interacted model[b]	4 Medicaid enrollment sensitivity model	5 Percent insured sensitivity model
Medicaid expansion (average effect)	1.42 [-12.2,15.1]				
Medicaid expansion (bottom third)		-10.9 [-22.4,0.73]	16.6 [-8.90,42.1]		
Expansion x middle third		8.77 [-19.8,37.3]	-17.5 [-48.5,13.5]		
Expansion x top third		22.7* [4.19,41.1]	-25.6 [-53.8,2.66]		
Unemployment (%)	-2.30 [-5.66,1.06]	-1.97 [-5.14,1.21]	-1.47 [-5.15,2.20]	-0.67 [-3.93,2.59]	-2.44 [-5.77,0.89]
Population (10,000s)	0.21** [0.079,0.35]	0.22** [0.066,0.36]	0.19** [0.055,0.32]	0.058 [-0.13,0.25]	0.22** [0.077,0.36]
Poverty Rate (%)	4.60 [-0.53,9.74]	3.45 [-1.24,8.14]	3.41 [-1.85,8.66]	2.62 [-2.34,7.57]	4.67 [-0.52,9.86]
Medicaid enrollments (100,000s)				1.86 [-0.80,4.52]	
Insurance Rate (%)					-0.49 [-2.51,1.53]
State-years	540	540	540	540	540

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[a] States are divided into thirds by the number of buprenorphine waivers per 100,000 people in 2013. Bottom third states (12 waivers per 100,000 persons, 8 expansion states, 7 non-expansion states): AR, IA, IL, IN, KS, MN, MO, MT, NC, ND, NE, NH, OK, TX, WY. Middle third states (23 waivers per 100,000 persons, 8 expansion states, 7 non-expansion states): AL, AZ, CA, CO, DE, FL, GA, HI, NV, OH, SC, TN, VA, WI, WV. Top third states (52 waivers per 100,000 persons, 13 expansion states, 2 non-expansion states): AK, CT, MA, MD, ME, MI, NJ, NM, NY, OR, PA, RI, UT, VT, WA.

[b] States are divided into third by the percent of physicians accepting Medicaid in 2011. Bottom third states (63% of physicians accept Medicaid, 8 expansion states, 7 non-expansion states): AL, CA, CO, CT, FL, GA, IL KS, MD, MO, NJ, NY, OK, PA, TN. Middle third states (75% of physicians accept Medicaid, 4 expansion states, 11 non-expansion states): AZ, DE, HI, IN, MA, ME, NC, NV, OH, OR, RI, TX, VA, VT, WA. Top third states (88% of physicians accept Medicaid, 5 expansion states, 10 non-expansion states): AK, AR, IA, MI, MN, MT, ND, NE, NH, NM, SC, UT, WI, WV, WY.

Supplemental Table 1. Sensitivity Analyses of the Effect of Medicaid Expansion on Methadone Use

		OTP concentration			Percent of OTPs accepting Medicaid		
Drop post-2014 expansion states	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	23.9	5.35	47.7	12.7	13.9	34.2	-10.8
	[-46.4,94.2]	[-52.6,63.3]	[-32.3,127.6]	[-49.9,75.2]	[-48.5,76.2]	[-18.6,87.0]	[-74.5,53.0]
State-years	324	324	324	324	324	324	324
Drop pre-2014 expansion states	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	-9	-10.2	4.4	-0.31	-15.3	27	-11.3
	[-66.5,48.5]	[-75.4,55.0]	[-54.7,63.5]	[-79.6,78.9]	[-81.1,50.4]	[-28.8,82.7]	[-96.1,73.4]
State-years	276	276	276	276	276	276	276
Drop 1115 waiver expansion states	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	25.7	4.14	59.3	17.5	12.9	40	-7.88
	[-46.5,97.8]	[-51.9,60.2]	[-35.0,153.6]	[-52.9,87.9]	[-45.5,71.4]	[-18.4,98.4]	[-80.7,64.9]
State-years	300	300	300	300	300	300	300
Include methadone coverage up to 2013	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	29.7	9.17	40.4	19.6	19.5	27.5	-4.03
	[-30.2,89.6]	[-42.5,60.9]	[-18.6,99.4]	[-36.7,75.9]	[-37.2,76.2]	[-15.1,70.1]	[-61.1,53.0]
State-years	372	372	372	372	372	372	372
Include PDMP laws	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	27	13.5	41.3	7.89	25.1	24	-19.8
	[-39.7,93.6]	[-44.4,71.4]	[-37.6,120.3]	[-55.3,71.1]	[-39.6,89.8]	[-33.8,81.8]	[-89.1,49.4]
State-years	336	336	336	336	336	336	336

95% confidence intervals in brackets

The first column presents estimates from models of the average effect of Medicaid expansion. Columns 2-4 present estimates from models interacting a Medicaid expansion indicator with indicators for the tercile of OTP concentration. Columns 5-7 present estimates from models interacting a Medicaid expansion indicator with indicators for the tercile of OTP Medicaid acceptance. The coefficients from covariates are not presented for brevity. The first row excludes states that expanded Medicaid after 2014. The second row excludes states that gradually expanded Medicaid prior to 2014. The third row excludes states that expanded Medicaid via 1115 waivers. The fourth row includes states that covered methadone through Medicaid at any point prior to 2013, rather than 2007 as in the main model. The last row controls for PDMP laws and mandates.

Supplemental Table 2. Sensitivity Analyses of the Effect of Medicaid Expansion on Buprenorphine Use

		Concentration of waivered providers			Percent of providers accepting Medicaid		
Drop post-2014 expansion states	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	0.14	-11.8	10.2	20.6*	8.11	-8.85	-14.1
	[-14.9,15.2]	[-24.1,0.44]	[-18.3,38.7]	[5.01,36.1]	[-14.5,30.7]	[-37.3,19.6]	[-36.8,8.64]
State-years	492	492	492	492	492	492	492
Drop pre-2014 expansion states	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	2.69	-9.8	8.11	24.6*	13.4	-8.88	-22.5
	[-12.9,18.2]	[-21.8,2.24]	[-22.8,39.0]	[1.41,47.7]	[-17.0,43.7]	[-46.7,29.0]	[-55.7,10.6]
State-years	480	480	480	480	480	480	480
Drop 1115 waiver expansion states	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	4.01	-11.8	11.1	26.4*	16.5	-18.8	-20.9
	[-12.5,20.5]	[-26.3,2.57]	[-14.5,36.8]	[1.45,51.3]	[-9.65,42.6]	[-56.6,19.1]	[-51.9,10.00]
State-years	456	456	456	456	456	456	456
Include buprenorphine coverage up to 2013	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	5.38	-8.9	15.4	22.9*	15	-6.45	-23.5
	[-7.57,18.3]	[-19.2,1.39]	[-11.0,41.8]	[4.67,41.2]	[-7.68,37.7]	[-35.7,22.8]	[-49.0,1.99]
State-years	600	600	600	600	600	600	600
Include PDMP laws	All states	Bottom third	Expansion x middle third	Expansion x top third	Bottom third	Expansion x middle third	Expansion x top third
Medicaid expansion	-1.61	-9.84	4.1	17.4*	11.7	-15.1	-22.2
	[-13.2,10.0]	[-21.0,1.28]	[-21.5,29.7]	[1.26,33.5]	[-10.9,34.3]	[-43.9,13.6]	[-47.1,2.79]
State-years	540	540	540	540	540	540	540

95% confidence intervals in brackets, * $p < 0.05$

The first column presents estimates from models of the average effect of Medicaid expansion. Columns 2-4 present estimates from models interacting a Medicaid expansion indicator with indicators for the tercile of waiver concentration. Columns 5-7 present estimates from models interacting a Medicaid expansion indicator with indicators for the tercile of physician Medicaid acceptance. The coefficients from covariates are not presented for brevity. The first row excludes states that expanded Medicaid after 2014. The second row excludes states that gradually expanded Medicaid prior to 2014. The third row excludes states that expanded Medicaid via 1115 waivers. The fourth row includes states that covered buprenorphine through Medicaid at any point prior to 2013, rather than 2007 as in the main model. The last row controls for PDMP laws and mandates.

Supplemental Table 3. Summary of Measures of OAT Provider Capacity

Construct	Measure	Data source
Methadone capacity	OTPs per population in 2013	National Survey of Substance Abuse Treatment Services
Buprenorphine capacity	Buprenorphine waivers per population in 2013	Substance Abuse and Mental Health Services Administration
Methadone providers' Medicaid acceptance	Percent of OTPs accepting Medicaid in 2013	National Survey of Substance Abuse Treatment Services
Buprenorphine providers' Medicaid acceptance	Percent of all physician accepting Medicaid in 2011	National Ambulatory Medical Care Survey Electronic Medical Records Supplement

CHAPTER 2: IMPROVEMENTS IN QUALITY OF BUPRENORPHINE TREATMENT AND DIFFERENCES BY PROVIDER CHARACTERISTICS IN NORTH CAROLINA MEDICAID

Introduction

Though opioid agonist treatment (OAT) for opioid use disorder (OUD) is effective in reducing illicit opioid use,[8] OAT is vastly underutilized in the treatment of OUD.[9] In response to high rates of opioid overdose deaths, states have been working to increase access to OAT.[23] These efforts have focused on expanding office-based OAT by mobilizing providers, especially primary care providers (PCPs), to offer buprenorphine treatment.[24,25] Treatment expansion is particularly important within Medicaid since it is the largest single payer of substance use treatment.[66]

Simply ensuring buprenorphine treatment is available, however, does not guarantee that patients are receiving high quality care. Efforts to increase OAT access may come at the cost of treatment quality if providers newly offering OAT do not have the appropriate training or resources. Indeed, concerns have been raised that PCPs, who are the focus of many efforts to expand access, lack the expertise to provide buprenorphine treatment for OUD.[14] Despite these concerns, there are no studies of differences in buprenorphine treatment quality by provider characteristics.

Measuring quality of buprenorphine treatment is challenging because of a lack of consensus concerning quality measures.[67,68] Guideline adherence is one possible approach to quality measurement. There is evidence that process measures in treatment of OUD—such as not

being prescribed opioids or benzodiazepines, receipt of any psychosocial treatment, and quarterly physician visits—are associated with lower mortality.[69] Nevertheless, studies have found variable levels of guideline adherence in Medicaid programs,[70,71] though these studies are several years old.

Despite the potential benefits of some guideline-adherent practices, guideline adherence has limitations as a quality measure. There is limited evidence to support some guidelines, and there is increasing recognition of the importance of individualization in OAT.[72] A complementary measure of quality is retention in treatment, which has been consistently found to be associated with lower mortality.[16] The National Quality Forum (NQF) has endorsed retention in OUD pharmacotherapy for at least 180 days as a quality measure.[27] Studies have found retention in OUD buprenorphine treatment to be highly variable across patient groups and treatment settings.[17,73–76] A study of buprenorphine treatment retention across settings found the percent of patients retained at 6-months was 21% at an opioid treatment program, 33% in a primary care settings , and 55% in an outpatient behavioral health program.[77]

The objective of this study was to quantify trends in buprenorphine treatment quality in North Carolina's Medicaid program and to examine differences in quality by provider characteristics. North Carolina has responded to rising opioid overdose deaths in part by funding trainings for providers to obtain buprenorphine waivers and supporting UNC ECHO for MAT,[78] a program to support providers offering medication treatment for OUD.[79] This research provides evidence of whether increases in treatment access may be coming at the cost of quality. This research also elucidates whether non-specialist providers are delivering buprenorphine treatment at similar quality levels as specialists. The results can be used to inform efforts to improve buprenorphine treatment quality as treatment expansion efforts continue.

Methods

Conceptual Model

This study is guided by the interdisciplinary conceptual framework for physician compliance with evidence-based guidelines.[26] This framework proposes that adherence to guidelines is determined by system characteristics, provider characteristics, guidelines characteristics, and implementation characteristics. This study focuses on system and provider characteristics. The specific model constructs inform the characteristics we examined: provider specialty (awareness), treatment setting (organizational characteristics), number of patients (motivation), rural/urban (tools-technology), length of time providing prescribing buprenorphine (familiarity), and provider gender (subjective norms). Treatment retention may be viewed as a guideline insofar as providers determine the length of treatment or as a patient outcome insofar as patients may face barriers to remaining in treatment. As an outcome, the framework posits that retention would be affected by patient characteristics, so we controlled for patient comorbidities when modeling retention.

Data

We accessed Medicaid claims and encounter data from North Carolina through the Carolina Cost and Quality Initiative from January 2014 to July 2018.[80] Approximately 18% of North Carolina's population is covered by Medicaid, which was not expanded under the Affordable Care Act.[81] Since Medicaid beneficiaries have disproportionately high rates of OUD, our sample likely includes substantially more than 18% of people with OUD in North Carolina.[82] North Carolina's Medicaid program is currently a fee-for-service program, but has a capitated behavioral health (BH) carve-out wherein BH services are managed by regional managed care organizations (MCOs). Our data included all claims from fee-for-service Medicaid and encounter data from the MCOs for individuals 18 and older.

OUD Diagnosis and Treatment

We organized our data at the level of buprenorphine treatment episodes. We defined the population with OUD broadly as: (1) individuals with any claim containing an International Classification of Diseases (ICD) code for opioid abuse, dependence, or poisoning; or (2) individuals with any claim for methadone from an opioid treatment program or for a buprenorphine formulation for OUD treatment. We excluded individuals whose only OUD diagnoses appeared in laboratory claims, since these may represent diagnoses of exclusion for individuals tested for OUD. We defined buprenorphine treatment episodes as periods of continuous buprenorphine prescriptions coverage without more than a 30-day gap. We included in our analyses only treatment episodes that began before January 1, 2018, to allow for at least 6 months of follow-up observation.

Quality Measures

We assessed quality of buprenorphine treatment for each episode with a measure of treatment retention and eight measures of guideline adherence. We measured treatment retention as continuous receipt of buprenorphine for at least 180 days. We based guideline adherence measures on recommendations from the American Society of Addiction Medicine (ASAM).[28,83]

We measured receipt of each of the following recommended services during an episode: HIV test, HCV test, naloxone prescription, or any outpatient behavioral health (BH) service. We counted the services as provided if they occurred during a treatment episode or up to a week before the start of an episode, in case the services were delivered in a visit prior to buprenorphine induction. While there is no evidence that receipt of BH services improves outcomes in buprenorphine treatment,[84] ASAM recommends that patients receive at minimum an assessment of psychosocial needs and referral to appropriate services.[28]

We also measured whether patients received at least one evaluation and management (E&M) visit and at least one toxicological test every 30 days during a treatment episode. We counted multiple procedures in a day as a single E&M visit or toxicological test. While there is recognition that the frequency of provider visits and toxicological testing should be adjusted based on patients' needs, ASAM recommends these occur at least monthly.[28]

We measured receipt of any opioid prescriptions or benzodiazepine prescriptions during an episode. Concurrent opioid or benzodiazepine use is discouraged during buprenorphine treatment, though it is not an absolute contraindication. Short-term opioid use may be appropriate for patients who undergo surgery while on buprenorphine treatment, for instance.[28]

We measured receipt of HIV, HCV, BH visits, EM visits, and toxicology testing using Current Procedural Terminology (CPT) codes used by North Carolina Medicaid (see Appendix 1 Table A1).[85] In addition to standard E&M codes, we included in our definition of E&M visits codes for bundled outpatient substance use disorder (SUD) services that include medication management. We included psychological, psychiatric, and SUD assessments and services in our definition of BH visits. We defined concurrent receipt of naloxone, opioid, and benzodiazepine prescriptions as prescription claims for these drugs that started during the buprenorphine treatment episode. We examined whether opioid and benzodiazepine prescriptions were from the same provider who prescribed buprenorphine for the treatment episode.

Provider Characteristics

Buprenorphine prescribers were identified using national provider identifiers (NPIs) listed as the prescriber in pharmacy claims. Only 0.13% of claims for buprenorphine were missing prescriber NPI. Treatment episodes were assigned to the provider who prescribed the most buprenorphine prescriptions in the episode. We used NPIs to link buprenorphine prescribers to the National Plan and Provider Enumeration System (NPPES) data with a 100%

match. We used the primary taxonomy in NPPES to identify providers as PCPs, BH specialists, pain specialists, or other providers. We defined PCPs as providers whose primary taxonomy was family medicine, internal medicine, non-psychiatric nurse practitioner, or physician assistant. We defined pain specialists as providers whose primarily taxonomy was anesthesiology or pain medicine. We defined BH specialists as providers whose primary taxonomy was psychiatry or psychiatric nurse practitioner. We could not observe whether providers were board certified in an addiction subspecialty. To identify provider who may have specialized training in addiction, we created a binary variable of whether any of the NPPES or claims taxonomies indicated the provider was an addiction specialist regardless of primary specialty. We also used NPPES to determine providers' gender.

To identify providers' treatment setting, we assigned providers to the most frequent place of service codes and billing taxonomies in their service claims for patients with OUD. We grouped treatment settings into offices, hospitals, BH centers, and federally qualified health centers (FQHCs). In addition to place of service codes and billing taxonomies, we identified FQHCS using FQHC-specific billing codes and a list of NPIs for FQHCs in North Carolina. BH centers included opioid treatment programs, and hospitals included hospital-based outpatient clinics. We were unable to determine a treatment setting for 26% of providers and created a separate category for missing setting. Approximately 75% of these providers only appeared in pharmaceutical claims, suggesting the providers likely do not bill Medicaid for visits. The remaining providers had claims that were missing place of service, billing taxonomy, or billing codes that could be used to identify treatment settings. We created a binary variable of whether providers were associated with claims from practices that are recognized as patient-centered medical homes (PCMH) by NC Medicaid and received special capitation payments.

For each episode, we measured how many patients the episodes' prescriber had treated with buprenorphine prior to that episode and how long the prescriber had been observed prescribing buprenorphine prior to that episode from the start of the data period (2014). We also identified the provider as based in a rural county using their listed county in claims data and the USDA categories for completely rural counties.[86]

Statistical Analysis

Using a dataset of treatment episodes, we used generalized estimation equations (GEE) to model the association between provider characteristics and quality measures. The mean variance inflation factor was 1.23 and the highest value was 1.84, suggesting multicollinearity was not a concern. Models with an unstructured correlation structure did not converge, so we used an exchangeable structure to account for correlations between treatment episodes from the same providers. We used a logit link function and binomial distribution for all outcomes except receipt of toxicology testing and receipt of a BH visit, for which these models did not converge. For these outcomes, we used an identity link function with a gaussian distribution, obtaining only about 1% out of range predictions.

We controlled for episode length in models of guideline adherence to account for providers having more time to deliver guideline concordant services in longer episodes. We controlled for patient comorbidities in the treatment retention model to account for competing health needs that may affect patients' retention. We included disease-specific indicators of whether patients had depression, anxiety, bipolar disorder, schizophrenia, alcohol use disorder, other substance use disorder, chronic pain, diabetes, coronary artery disease, and chronic obstructive pulmonary disease. The disease-specific indicators were based on whether patients had any service claims during the time period for each condition.

Results

The number of adults with documented OUD in Medicaid increased by 65% from 26,470 in 2014 to 43,636 in 2017 (Figure 1). The number of people receiving buprenorphine in a year increased by 74% from 6,410 in 2014 to 11,157 in 2017, and the number receiving methadone increased by 41% from 4,551 in 2014 to 6,417 in 2017. Increases in OUD prevalence outstripped increases in treatment as the percent of people with OUD who received OAT in a year fell slightly from 42% in 2014 to 41% in 2017.

Figure 3 presents the percent of episodes active in each year achieving quality measures. The percent of episodes achieving quality measures improved for all measures from 2014 to 2017. Retention for at least 180 days increased from 57% in 2014 to 65% in 2017. Several quality measures improved substantially from 2014 to 2016 and then fell slightly in 2017, including retention. There was a more substantial fall in toxicological testing in 2017, which may be due to a cap on the number of Medicaid-reimbursed tests beginning in 2017.

Despite improvements, several quality measures remained low. Only 3.7% of episodes included a Medicaid-funded naloxone prescription fill and only 25% included a HIV test. A substantial proportion of episodes continued to include receipt of a benzodiazepine (22%) or an opioid (26%) in 2017. However, these prescriptions were typically not from the buprenorphine prescribers. Thirty percent of episodes did not include any E&M visits with the buprenorphine prescriber in 2017. The prescribers for these episodes may be cash-only providers who do not accept Medicaid reimbursement for visits. When excluding episodes without E&M visits with the prescriber, the 30-day visit frequency for 2017 was 89%, compared to 73% when including these episodes.

Providers of different specialties differed in all characteristics except rurality (Appendix 1 Table A2). BH specialists were most likely to identify themselves as addiction specialists. BH

specialists had longer observed times prescribing buprenorphine and treated more prior patients than PCPs. Pain providers, while a small group (n=39), had the longest observed time prescribing buprenorphine and the most buprenorphine patients per provider.

Table 3 presents unadjusted measures of quality outcomes by prescriber specialty. The percent of episodes achieving quality outcomes differed between specialties for all outcomes except concurrent opioid prescription. Episodes where the prescriber was a PCP were most likely to have at least one visit per 30 days and to receive HIV and HCV testing. Episodes with pain specialists were most likely to have one toxicological test per 30 days, to have a naloxone prescription, and to have a concurrent opioid prescription. BH specialists were most likely to prescribe concurrent benzodiazepines and least likely to have a visit every 30 days.

When adjusting for all provider characteristics, primary care providers' patients had similar rates of retention as BH specialists and other providers, but pain specialists were less likely to achieve to achieve 180-day retention compared PCPs (Table 4). Episodes where the provider had longer time prescribing buprenorphine prior to the current episode were also associated with a slightly lower probability of achieving 180-day retention. Hospital-based providers and providers with unknown treatment settings were also less to achieve 180-day retention compared to office-based providers.

BH specialists were less likely to have regular visits, less likely to provide HIV and HCV testing, and more likely to provide concurrent benzodiazepines compared to PCPs. They were also more likely to provide any psychosocial visit and less likely to provide concurrent opioids compared to PCPs. Pain providers were more likely than PCPs to provide naloxone and less likely to prescribe concurrent benzodiazepines.

Addiction specialists were more likely to prescribe naloxone but otherwise were not different from non-specialists. Longer time providing buprenorphine and treating more buprenorphine patients were associated with higher probability of guideline adherence for several measures including regular visits, regular toxicology testing, and naloxone prescription.

Female providers were more likely to provide guideline adherent care than male providers across all measures except for concurrent opioid prescription and HIV testing where there were no differences. Rural providers were less likely to provide guideline-concordant care compared to non-rural providers for all measures except concurrent opioid prescription where there was no difference.

Providers in PCMHs were more likely to have regular visits, provide naloxone, and conduct HCV testing but less likely to have regular toxicology testing. Hospital-based providers and providers with unknown treatment settings were less likely to achieve several measures of guideline-adherence, including regular visits, regular toxicology testing, naloxone prescription, HIV testing, and HCV testing. FQHC providers were less likely to have regular visits and less likely to provide concurrent opioids.

In adjusted analyses, episodes that started in later years generally remained more likely than episodes starting in 2014 to achieve guideline adherence, suggesting improvements across years were not wholly explainable by changes in the types of providers prescribing buprenorphine. Put differently, the results suggest improvements in guideline adherence were driven by changes in providers' practices across different provider types rather than just by changes in the composition of providers prescribing buprenorphine.

Discussion

We found that expansion of buprenorphine treatment in NC Medicaid did not come at the cost of quality. Quality measures for buprenorphine treatment generally improved from 2014 to

2017 even as the number of people with OUD receiving buprenorphine treatment increased by 74%. Nevertheless, increases in the prevalence of documented OUD outstripped increases in treatment, so that the percent of people with OUD receiving OAT remained stable during the study period.

The only substantial fall in quality outcomes was in toxicological testing. This fall was likely driven by a cap in the number of Medicaid-paid toxicological tests starting in 2017. This result points to the importance of payer policies in influencing providers' adherence to recommended practices. A planned follow-up study will examine the effect of this and other Medicaid policy changes on buprenorphine treatment outcomes in North Carolina.

Most buprenorphine prescribers were PCPs, suggesting that policies and programs to expand provision of office-based OAT are paying off.[78,79] Among those efforts in NC is UNC ECHO for MAT, a program that provides training and support for providers of office-based OAT. Interviews with providers participating in UNC ECHO for MAT found that the providers benefited from training and mentorship, though they noted other barriers to OAT provision remained, such as low reimbursement, prior authorization policies, and lack of psychosocial resources.[87]

This is the first study to compare adherence to buprenorphine treatment guidelines by provider characteristics. Despite concerns that PCPs are not equipped to treat OUD,[14] specialist providers were generally no more likely to provide guideline-adherent care than PCPs. In fact, PCPs were more likely than BH specialists to follow guidelines for several measures. Lack of integration of BH specialists with physical health facilities and equipment may be a barrier to the provision of HIV, HCV, and toxicology testing, or BH specialists may see these services as

outside of their clinical domains. These results support the role of PCPs in expanding access to OUD treatment.

Despite improvements in quality measures, several measures remained low, suggesting the need for continuing quality improvement efforts. The low level of naloxone prescription is particularly striking, though it is consistent with earlier research showing low levels of Medicaid-paid naloxone.[88] North Carolina passed a standing order law in 2016 allowing anyone in the state to purchase naloxone without an individual prescription. Prior research found such laws to be associated with increased naloxone dispensed.[88,89] Our results show increases in naloxone prescription but highlight how naloxone dispensing remains uncommon in Medicaid. We were unable to observe whether patients received naloxone through community-distribution programs.

Longer time prescribing buprenorphine and more prior patients treated with buprenorphine were associated with higher levels of guideline adherence, suggesting adherence may improve with experience. Providers in rural areas were less likely to adhere to several guidelines. This may result from lack of resources or longer distance to services, such as BH services, in rural areas. Future studies may examine specific barriers to guideline-adherence in these contexts. Female providers were a minority of all specialties, comprising less than 10% of pain specialists in our sample. Nevertheless, they more frequently delivered guideline-adherent care compared to male providers across nearly all measures. These results are consistent with studies from other areas of medicine that have found that female providers achieve higher quality measures.[90–92]

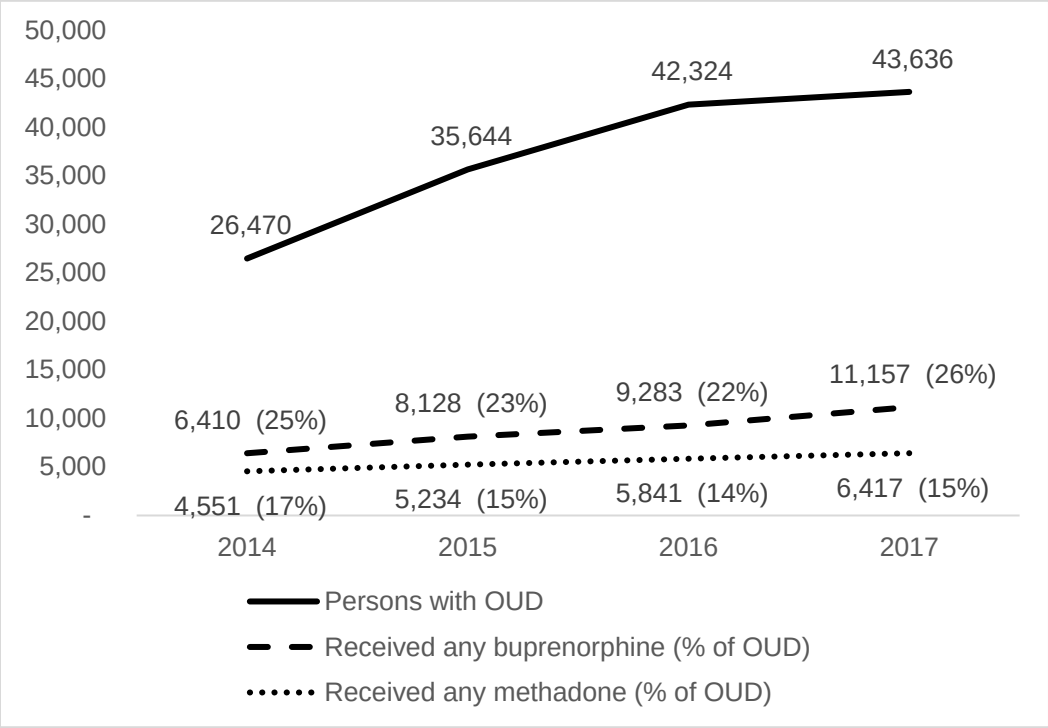
Controlling for patients' comorbidities did not explain away differences in retention by provider characteristics, suggesting provider-level factors such as resource availability and approaches to treatment could be partially determining retention. Pain specialists were less likely

to retain patients in care, possibly because pain providers are more likely to limit treatment length or discharge patients for perceived treatment noncompliance.[31] We are conducting a mixed-methods study to better elucidate patient and provider factors that drive retention.

Our study suffers from limitations inherent to the use of administrative data. We could only observe Medicaid-funded services, which may have underestimated our measures of guideline adherent services if they were paid by other sources. There was likely also measurement error in our identification of provider characteristics in claims data because of inaccurate, outdated, or incomplete information. In addition, we have left censoring on prescribers' treatment histories since we are unable to examine prescribing prior to 2014 and from non-Medicaid patients. We took several strategies to address these limitations including using multiple approaches to identify variables and merging claims with other data sources. We do not believe the measurement error introduced bias in our results. As discussed above, guideline adherence and treatment retention also have limitations as measures of quality in buprenorphine treatment.[68] The development of improved quality measures in OUD treatment continues to be an important topic in the field.

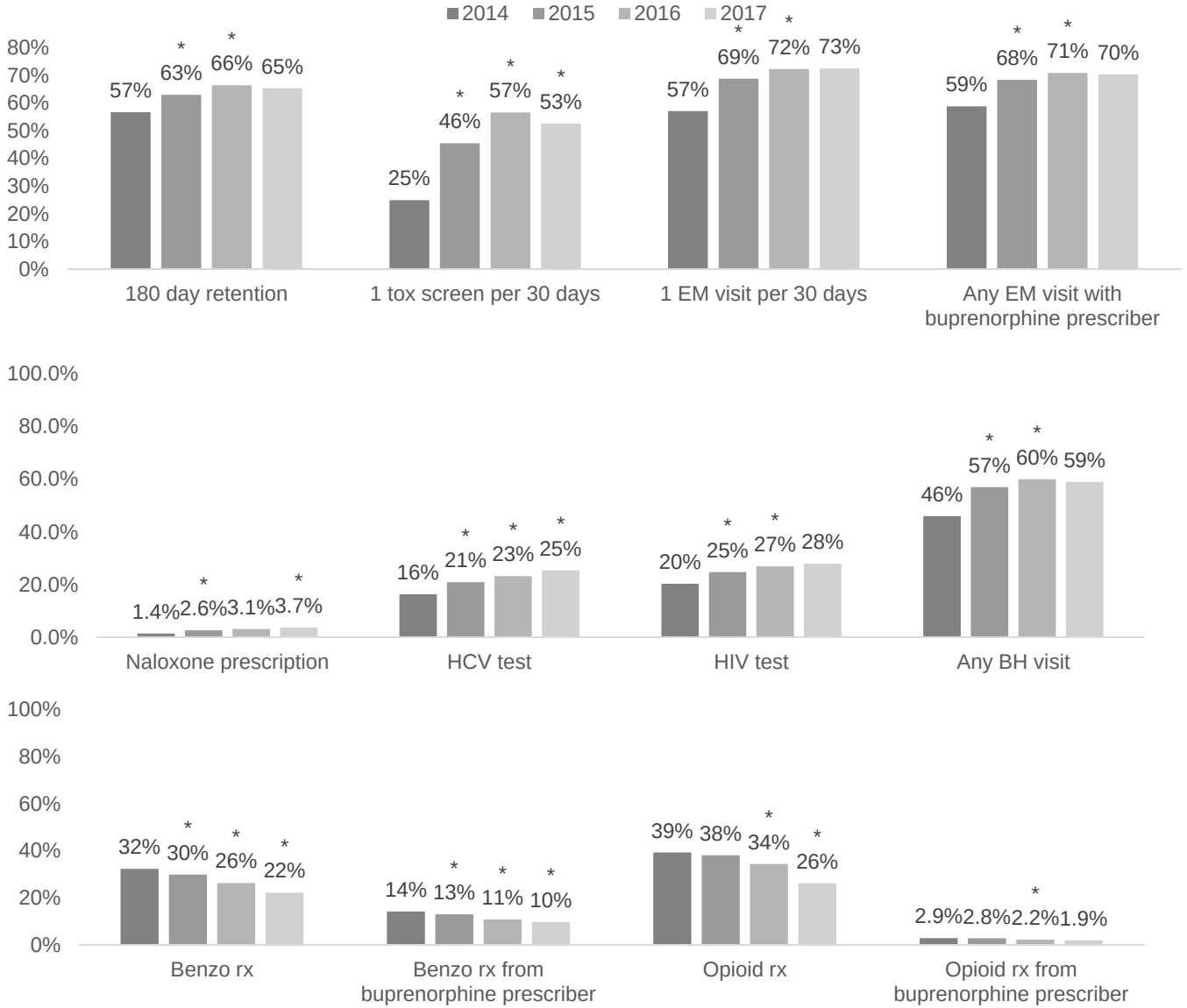
In all, our results suggest treatment quality for buprenorphine treatment is improving though there remains room for improvement in both quality and access. Our results support the important role of PCPs in continuing to expand high-quality treatment for OUD.

Figure 2. Yearly OUD Prevalence and OAT Receipt in NC Medicaid



Yearly number of Medicaid enrollees with OUD claims and yearly number with buprenorphine or methadone claims for OUD treatment.

Figure 3. Percent of Buprenorphine Treatment Episodes Achieving Quality Measures by Year



* p<.05 from chi-2 test of current year against previous year.

Table 3. Unadjusted Percent of Treatment Episodes Achieving Quality Measures by Provider Specialty

	PCPs (12,221 episodes)	BH providers (9,624 episodes)	Pain specialists (2,574 episodes)	Other providers (1,612 episodes)	p-value
180-day retention	6235 (51%)	4733 (49%)	1105 (43%)	856 (53%)	<0.001
Episode length	336 (390)	334 (404)	275 (345)	332 (367)	<0.001
Any E&M visit with prescriber	8290 (68%)	5493 (57%)	1708 (66%)	1029 (64%)	<0.001
At least 1 E&M visit per 30d	9015 (74%)	5546 (58%)	2019 (78%)	1005 (62%)	<0.001
Number of visits per 30d	2.1 (2.3)	2.0 (2.7)	2.3 (2.2)	1.8 (2.3)	<0.001
At least 1 tox screen per 30d	5543 (45%)	4562 (47%)	1540 (60%)	627 (39%)	<0.001
Number of screens per 30d	1.4 (1.8)	1.6 (2.2)	1.6 (1.7)	1.2 (1.8)	<0.001
At least 1 BH visit	5723 (47%)	5766 (60%)	1016 (40%)	841 (52%)	<0.001
Number of BH visits per 30d	.84 (1.9)	1.5 (2.5)	.77 (2.0)	1.2 (1.8)	<0.001
Any naloxone rx	314 (2.6%)	149 (1.5%)	107 (4.2%)	28 (1.7%)	<0.001
Any HIV test	2859 (23%)	1788 (19%)	430 (17%)	368 (23%)	<0.001
Any HCV test	2642 (22%)	1462 (15%)	413 (16%)	313 (20%)	<0.001
Any opioid rx	3204 (26%)	2598 (27%)	660 (26%)	437 (27%)	0.41
Opioid rx from buprenorphine prescriber	233 (1.9%)	101 (1.0%)	119 (4.6%)	49 (3.0%)	<0.001
Any benzo rx	2751 (22%)	2180 (23%)	646 (25%)	387 (24%)	0.025
Benzo rx from buprenorphine prescriber	1141 (9.3%)	1062 (11.0%)	84 (3.3%)	148 (9.2%)	<0.001
Average daily dose buprenorphine (mg)	15.7 (6.84)	15.8 (6.26)	16.0 (15.5)	17.3 (5.64)	<0.001

For continuous variables, means are presented with standard deviations in parentheses and p-values from ANOVA tests. For binary and categorical variables, counts are presented with percentages in parenthesis and p-values from chi-squared tests.

Table 4. Association Between Prescriber Characteristics and Quality Measures in Buprenorphine Treatment Episodes

	Retention 180d[a]	E&M/30d	Tox/30d	Any BH visit
Specialty (PCP ref)				
BH	-0.027	**-0.16****	-0.050	**0.080***
	[-0.064,0.0094]	**[-0.20,-0.11]**	[-0.11,0.011]	**[0.028,0.13]**
Pain	**-0.079**	0.055	0.030	-0.020
	[-0.14,-0.014]	[-0.017,0.13]	[-0.084,0.14]	[-0.12,0.076]
Other	-0.033	**-0.083**	-0.048	0.051
	[-0.092,0.025]	**[-0.16,-0.011]**	[-0.14,0.044]	[-0.030,0.13]
Addiction specialist	-0.00086	-0.026	0.011	-0.0070
	[-0.044,0.042]	[-0.080,0.028]	[-0.064,0.085]	[-0.070,0.056]
Prior days prescribing buprenorphine (100)	**-0.010****	**0.0062****	**0.0100****	**0.0056***
	[-0.014,-0.0067]	**[0.0027,0.0098]**	**[0.0063,0.014]**	**[0.0018,0.0094]**
Prior patients treated with buprenorphine (100)	-0.0068	**0.040****	**0.027****	-0.0040
	[-0.021,0.0076]	**[0.025,0.054]**	**[0.015,0.039]**	[-0.017,0.0090]
Female	-0.023	**0.093****	**0.089***	**0.11****
	[-0.057,0.011]	**[0.055,0.13]**	**[0.035,0.14]**	**[0.060,0.15]**
Rural	0.0079	**-0.091****	**-0.093***	**-0.15****
	[-0.033,0.049]	**[-0.14,-0.039]**	**[-0.16,-0.025]**	**[-0.21,-0.093]**
PCMH	-0.015	**0.054***	**-0.069***	0.027
	[-0.050,0.020]	**[0.011,0.096]**	**[-0.13,-0.0099]**	[-0.023,0.078]
Setting (office ref)				
Hospital	**-0.12****	**-0.27****	**-0.21****	**-0.11***
	[-0.16,-0.067]	**[-0.33,-0.21]**	**[-0.29,-0.14]**	**[-0.18,-0.044]**
BH center	-0.028	-0.041	-0.063	**0.16****
	[-0.072,0.017]	[-0.097,0.015]	[-0.14,0.015]	**[0.091,0.22]**
FQHC	-0.012	**-0.30****	0.011	-0.032
	[-0.076,0.052]	**[-0.38,-0.23]**	[-0.087,0.11]	[-0.12,0.055]
Other	0.031	**-0.33****	-0.14	-0.048
	[-0.079,0.14]	**[-0.46,-0.20]**	[-0.30,0.016]	[-0.19,0.095]
Unknown	**-0.14****	**-0.41****	**-0.29****	**-0.19****
	[-0.20,-0.081]	**[-0.48,-0.34]**	**[-0.37,-0.20]**	**[-0.27,-0.11]**
Year episode started				

(2014 ref)					
2015	**-0.057****	**0.074****	**0.20****	**0.096****
	[-0.079,-0.035]	**[0.053,0.095]**	**[0.18,0.22]**	**[0.075,0.12]**
2016	-0.0017	0.023	**0.22****	**0.081****
	[-0.032,0.028]	[-0.0064,0.052]	**[0.19,0.25]**	**[0.051,0.11]**
2017	-0.0093	-0.014	**0.083****	**0.090****
	[-0.048,0.029]	[-0.053,0.024]	**[0.043,0.12]**	**[0.050,0.13]**
Episode days (100)		**0.0099****	**0.0063****	**0.037****
		[0.0084,0.011]	**[0.0051,0.0076]**	**[0.036,0.039]**
Observations	26021	26021	26021	26021

	Naloxone rx	**HIV test**	**HCV test**	**Opioid rx from prescriber**	**Benzo rx from prescriber**
Specialty (PCP ref)					
BH	-0.0061	**-0.035***	**-0.056****	**-0.014****	**0.031**
	[-0.012,0.00016]	**[-0.061,-0.0089]**	**[-0.080,-0.032]**	**[-0.022,-0.0060]**	**[0.0020,0.060]**
Pain	**0.023**	0.00095	-0.0025	0.015	**-0.052****
	[0.0049,0.041]	[-0.047,0.049]	[-0.047,0.042]	[-0.0047,0.035]	**[-0.081,-0.023]**
Other	0.0023	-0.0016	-0.012	0.0072	0.012
	[-0.012,0.016]	[-0.046,0.043]	[-0.054,0.030]	[-0.011,0.025]	[-0.033,0.057]
Addiction specialist	**0.012***	0.026	0.022	-0.0016	0.016
	[0.0024,0.022]	[-0.0058,0.058]	[-0.0073,0.051]	[-0.013,0.0097]	[-0.017,0.050]
Prior days prescribing buprenorphine (100)	**0.0018****	0.00020	0.0015	**-0.0015**	-0.0019
	[0.00091,0.0027]	[-0.0026,0.0030]	[-0.0011,0.0041]	**[-0.0026,-0.00026]**	[-0.0043,0.00045]
Prior patients treated with buprenorphine (100)	**-0.015****	0.0054	-0.0024	0.0018	**-0.011**
	[-0.020,-0.011]	[-0.0050,0.016]	[-0.012,0.0073]	[-0.0035,0.0071]	**[-0.021,-0.00092]**
Female	**0.020****	0.012	**0.024**	-0.0024	**-0.032***
	[0.011,0.029]	[-0.013,0.037]	**[0.0012,0.048]**	[-0.011,0.0065]	**[-0.055,-0.0099]**
Rural	**-0.0076***	**-0.064****	**-0.064****	0.0038	**0.090****
	[-0.014,-0.00094]	**[-0.090,-0.037]**	**[-0.087,-0.040]**	[-0.0070,0.015]	**[0.050,0.13]**
PCMH	**0.015****	0.025	**0.031***	-0.00026	0.0072
	[0.0085,0.022]	[-0.00023,0.051]	**[0.0078,0.054]**	[-0.0088,0.0083]	[-0.019,0.033]
Setting (office ref)					
Hospital	**0.016**	**-0.060****	**-0.045***	**-0.013**	-0.027

	[0.000022,0.031]	**[-0.095,-0.025]**	**[-0.078,-0.011]**	**[-0.024,-0.0018]**	[-0.062,0.0085]
BH center	**-0.017****	0.0042	0.021	**-0.021****	**-0.068****
	[-0.023,-0.011]	[-0.029,0.037]	[-0.011,0.052]	**[-0.029,-0.013]**	**[-0.094,-0.042]**
FQHC	-0.0012	0.0050	-0.00090	**-0.014**	-0.037
	[-0.013,0.011]	[-0.042,0.052]	[-0.043,0.041]	**[-0.027,-0.0016]**	[-0.079,0.0047]
Other	-0.0049	-0.047	**-0.078***	0.0025	0.032
	[-0.025,0.016]	[-0.12,0.024]	**[-0.13,-0.022]**	[-0.025,0.030]	[-0.058,0.12]
Unknown	-0.0094	**-0.068***	**-0.087****	-0.011	0.0013
	[-0.026,0.0071]	**[-0.11,-0.024]**	**[-0.13,-0.048]**	[-0.025,0.0033]	[-0.048,0.050]
Year episode started (2014 ref)					
2015	**0.018****	**0.048****	**0.051****	-0.00059	0.0088
	[0.013,0.023]	**[0.033,0.063]**	**[0.037,0.066]**	[-0.0074,0.0062]	[-0.0035,0.021]
2016	**0.015****	**0.055****	**0.060****	-0.0063	-0.0082
	[0.0086,0.021]	**[0.034,0.076]**	**[0.041,0.079]**	[-0.015,0.0027]	[-0.026,0.0100]
2017	**0.032****	**0.070****	**0.082****	-0.0073	-0.00076
	[0.022,0.042]	**[0.042,0.097]**	**[0.057,0.11]**	[-0.018,0.0035]	[-0.025,0.024]
Episode days (100)	**0.0046****	**0.026****	**0.022****	**0.0011****	**0.0058****
	[0.0039,0.0052]	**[0.025,0.028]**	**[0.021,0.024]**	**[0.00066,0.0015]**	**[0.0049,0.0067]**
Observations	26021	26021	26021	26021	26021

Marginal effects with 95% confidence intervals in brackets. Bolded cells are statistically significant at p<0.05. * $p < 0.01$, ** $p < 0.001$.

[a] The treatment retention model included indicators for whether patients had any service claims for the following conditions in the study period: depression, anxiety, bipolar disorder, schizophrenia, alcohol use disorder, other substance use disorder, chronic pain, diabetes, coronary artery disease, and chronic obstructive pulmonary disease.

CHAPTER 3: A MIXED METHODS STUDY OF PROVIDER-LEVEL DIFFERENCES IN BUPRENORPHINE TREATMENT RETENTION FOR OPIOID USE DISORDER

Introduction

A persistent challenge in the delivery of buprenorphine treatment for opioid use disorder (OUD) is low treatment retention. Despite evidence that retention in buprenorphine treatment is associated with lower all-cause and overdose mortality,[16] buprenorphine retention rates remain highly variable in practice.[17] The National Quality Forum endorsed retention in OUD pharmacotherapy for at least 180 days as a quality measure.[27] Nevertheless, one study found that the percent of patients on buprenorphine retained at 6-months was 21% at an opioid treatment program, 33% in a primary care setting, and 55% in a behavioral health program.[77]

Despite the recognized importance of retention in buprenorphine treatment,[29,30] there is little research on why patients stop treatment. In a survey asking patients why they discontinued buprenorphine, reasons included incarceration, cost of treatment, and lack of transportation. However, the most frequent reasons were conflicts with treatment staff, involuntary discharge, and program inflexibility to accommodate patients' other obligations.[31] In contrast to methadone treatment for OUD, for which federal regulations impose strict rules on treatment programs, buprenorphine prescribers are free to determine the requirements and criteria for treatment.[11] However, providers may still choose to adopt strict practices. Burdensome or inflexible treatment approaches may be partially driving low retention.

Some providers have proposed low-threshold buprenorphine treatment models that emphasize flexibility in order to improve access and retention.[32] Low-threshold approaches can

include offering home-based induction, not requiring engagement with psychosocial services as part of treatment, and not discontinuing buprenorphine in response to illicit drug use. Some of these approaches, such as not requiring engagement with psychosocial services, are already reflected in current treatment guidelines.[28] However, there are no studies of whether low-threshold practices are associated with higher retention.

A challenge in studying whether low-threshold providers achieve better outcomes than high-threshold providers is that these provider groups may treat different types of patients. There is evidence from studies using secondary data sources that patient characteristics, such as younger age, white race, and comorbid substance use disorders, are associated with higher retention.[75] Differences in retention may also be driven by other factors that cannot be observed in secondary data such as patients' preferences, co-located psychosocial services, stigma, or treatment cost.

The goal of this study was to investigate factors driving differences in retention between providers while accounting for differences in patient characteristics. We accomplished this through an innovative mixed-methods study design combining claims data analysis and provider interviews. We hypothesized that high-retention providers offered more psychosocial services, minimized patients' out-of-pocket costs, and used low-threshold approaches to treatment.

Methods

We conducted a mixed methods study using North Carolina Medicaid claims data and interviews with providers. We used Medicaid claims to identify patient and provider characteristics associated with 180-day retention in treatment, as further described below. We then identified high and low-retention buprenorphine providers from the Medicaid claims data. Using a purposeful sampling approach, we then selected sub-groups of high- and low-retention providers whose patients had similar characteristics, in order to ensure that differences in

retention weren't driven by observable patient characteristics.[33] We interviewed providers from these groups about their treatment practices, resources, and attitudes that could affect retention.

The particular mixed-methods approach in this study follows a *quan* → *QUAL* structure wherein there is sequential collection and analysis of quantitative and qualitative data.[93,94] The mixed-methods approach serves the functions of complementarity, expansion, and sampling.[93] That is, the methods used offer answers to related questions, the qualitative methods provide insights into results from quantitative methods, and the quantitative methods provide a sampling basis for the qualitative methods.

Data

We accessed Medicaid claims and encounter data from North Carolina through the Carolina Cost and Quality Initiative from January 2014 to July 2018.[80] North Carolina's Medicaid program is a fee-for-service program with a capitated behavioral health (BH) carve-out wherein BH services are managed by managed care organizations (MCOs). Our data included all claims from fee-for-service Medicaid and encounter data from the MCOs for individuals 18 and older.

Buprenorphine Treatment and Retention

We identified Medicaid enrollees with claims for buprenorphine formulations for OUD treatment. We defined buprenorphine treatment episodes as periods of continuous buprenorphine prescription coverage without more than a 30-day gap. We assigned each episode to the provider prescribing the most buprenorphine prescriptions for the episode. We employed a binary measure of treatment retention as continuous receipt of buprenorphine for at least 180 days. We included in our analyses only treatment episodes that began between January 1, 2015 and December 31, 2017 to allow for 12-months of observation before episodes and 6 months of follow-up observation. We required patients to be Medicaid enrolled for at least 8 of the 12

months prior to the start of an episode and for all 6 months after the start of an episode. We included in our analyses only the first observed treatment episode for each patient.

Patient and Provider Characteristics

Our selection of patient and provider characteristics was informed by Simpson's conceptual framework for drug treatment process and outcomes.[34] Using claims data, we identified patients' demographic characteristics including age, gender, race, ethnicity, and rural county of residence based on the USDA categories for completely rural counties.[86] Patients with more severe substance use disorders or with competing comorbid conditions may be less likely to be retained in treatment. We identified whether patients had other comorbidities identified using non-diagnostic service claims for key physical, mental health, and substance use conditions using ICD codes in the 12-months before the start of treatment episodes. Inpatient or specialty service use may indicate more severe illnesses. We used CPT and revenue codes to quantify patients' use of specialty substance use services, behavioral health (BH) services, inpatient medical services, and emergency services in the 12 months prior to the start of buprenorphine treatment episodes (see Appendix 2 for codes).

We merged claims data with the National Plan & Provider Enumeration System (NPPES) to identify providers' specialty, grouping providers as primary care providers (PCPs), BH specialists, pain specialists, and other providers.[95] Regardless of providers' primary specialty, we created a binary variable of whether the provider was identified as an addiction specialist in claims or NPPES. We also identified the treatment setting where providers delivered most services for people with OUD and whether providers billed for services from a patient-centered medical home (PCMH) when treating people with OUD. PCMHs may have additional resources compared to other primary care offices, such as case management, that may help patients remain in treatment. We determined providers' gender using NPPES and whether they were in a rural

county using claims data. As measures of provider experience, we also quantified the number of patients that providers treated with buprenorphine prior to each episode and the length of time we observed providers prescribing buprenorphine prior to each episode. We identified receipt of certain services during treatment episodes such as evaluation & management (E&M) visits, BH visits, and toxicology testing using approaches described elsewhere.[95]

Statistical Analysis

Our analytic dataset was comprised of buprenorphine treatment episodes starting between January 1, 2015 and December 31, 2017. Each episode represented a single patient and was associated with that patients' characteristics. Similarly, every episode was associated with a provider's characteristics. We used generalized estimation equations (GEE) to model the association between 180-day retention and patient characteristics or provider characteristics. We used a logit link function, binomial distribution, and exchangeable correlation structure at the provider level for all models. We present average marginal effects with 95% confidence interval from delta method standard errors. To determine how well patient and provider characteristics predicted retention, we generated predicted probabilities of retention from our GEE models. We estimated the optimal cut-points for predicting retention using Liu's method for maximizing the product of the sensitivity and specificity.[96,97]

Provider Interviews

We conducted interviews from September to November 2019 to investigate factors that may be driving different retention rates between providers. We used a purposive sampling approach to identify high-retention and low-retention providers.[33] There were 513 unique buprenorphine prescribers in our Medicaid claims sample. To ensure we accurately observed providers' retention rates, we dropped 106 providers who treated less than 5 patients. To focus on providers who were more likely to be actively prescribing, we dropped 75 providers who we

did not observe prescribing buprenorphine in 2017. We divided providers into thirds by the percent of their patients who were retained in treatment for at least 180 days. We designated the bottom third of 111 providers as low-retention and the top third of 107 providers as high-retention.

Unsurprisingly, patient characteristics differed between high and low-retention providers. To minimize the extent to which differences in retention rates were driven by patient characteristics, we used coarsened exact matching to identify sub-groups of high and low-retention providers whose patients were similar in the characteristics that were independently associated with retention in our GEE model of patient characteristics (Table 2 – column 1).[98] This approach allowed us to focus interviews on providers whose differences in retention were likely not explained by observable differences in patient characteristics.

In developing our interview guide, we used Simpson's conceptual framework for drug treatment process and outcomes to identify key constructs that could affect retention.[34] We then used our treatment guidelines and our knowledge of treatment to develop questions about specific program characteristics, providers practices, and provider beliefs that could affect retention.[28,72,99] We piloted the interview guide with two addiction experts who were not in our study sample, making adjustments to ensure the guide's comprehensiveness and clarity. The final interview guide addressed aspects of providers' practice that could affect retention, including their criteria for prescribing buprenorphine, the psychosocial services they provided to buprenorphine patients, numerous aspects of their clinical practice, their attitudes towards buprenorphine treatment, and their patients' reasons for stopping buprenorphine (see Appendix 3).

We were unable to find current contact information for three of the 102 providers in our sub-sample. We contacted all of the remaining 99 providers for interviews at least once but not more than twice by phone or email, offering $100 gift cards for participation. We achieved thematic saturation between and within groups with 7 interviews in each group. We continued contacting providers for interviews until we conducted 3 additional interviews with each group to ensure no additional themes arose.[100] All interviews were conducted by AG in a structured manner emphasizing consistent presentation of questions to improve comparability between interviews. To guard against bias, AG could observe that providers were in groups labeled A and B but was blinded as to which group was high and low-retention.

We followed a qualitative content analysis approach to analyzing interviews divided into immersion, reduction, and interpretation.[101,102] Immersion involves becoming deeply familiar with the data, reduction involves identifying essential information in the data, and interpretation involves making sense of the essential information. We developed some themes deductively based on known areas of disagreement in buprenorphine treatment practice, such as require psychosocial treatment components and frequency of urine drug screening. We developed other themes inductively based on providers' answers, such as their motivations for providing buprenorphine treatment and their attitudes towards treatment effectiveness. We iteratively revised codes as interviews proceeded. AG and HMC double-coded all interviews, resolving discrepancies through concensus.[101,103] To guard against bias, AG and HMC were blinded as to which group was high and low-retention while coding. Researchers were unblinded to the groups after coding was completed. We then organized data into code reports and used the reports to develop matrices and interpretive summaries of the data.[101,104]

Some providers have proposed low-threshold buprenorphine treatment models that emphasize flexibility in order to improve retention. However, there is not yet consensus on what constitutes low-threshold treatment. To compare provider practices that may create barriers to retention, we identified five key high-threshold treatment practices based on Jakubowsky and Fox's framework.[32] We counted whether providers engaged in any of these five high-threshold practices: conducting office or facility-based inductions, requiring psychosocial treatment as part of buprenorphine treatment, discharging patients in response to positive drug screens, discharging patients in response to missed visits, and encouraging shorter treatment duration.

For combined analysis of quantitative and qualitative data, we followed a connecting process where qualitative data elaborated on quantitative data.[93] We sought from the interviews insights that might explain the quantitative associations. We also noted factors that appeared linked to retention in interviews that could not be measured in the quantitative data.

Results

Characteristics Associated with Retention

The overall 180-day retention rate was 48%. Treatment episodes that achieved 180-day retention differed from those that didn't in numerous patient and provider characteristics (Table 1). Some of these characteristics remained independently associated with retention in adjusted analyses (Table 2). Black and Latino patients had 11 percentage points lower probability to reach 180-day retention compared to white and non-Latino patients (95% CI -0.15 to -0.067 and -0.21 to -0.0097, respectively) (Table 2 – Column 1). Female patients had 5.2 percentage points (95% CI 0.026 to 0.078) higher probability of 180-day retention compared to men. Receiving services for opioid poisoning was associated with a 9 percentage point (95% CI -0.12 to -0.056) lower probability of 180-day retention, and receiving schizophrenia services was associated with a 5.4 percentage point (95% CI -0.090 to -0.018) lower probability of 180-day retention. Having more

ED visits in the 12 months before treatment was associated with lower retention, while having more specialty SUD visits before treatment was associated with higher retention.

PCPs, office-based providers, and rural providers were more likely to have episodes that achieved 180-day retention when controlling for provider characteristics (Table 2 – column 2). When simultaneously controlling for all patient and provider characteristics, rural providers were no longer associated with higher retention, but all other associations from the previous models remained statistically significant with similar coefficients (Table 2 – column 3). Optimal cut points for predicted probabilities correctly identified 180-day retention with 57% sensitivity and 55% specificity using the patient characteristics model, 53% sensitivity and 57% specificity using the provider characteristics model, and 56% sensitivity and 59% specificity using the combined model.

The coarsened exact matching procedure was successful in eliminating statistically significant differences between high- and low-retention providers for all patient characteristics except rates of anxiety disorder and chronic pain (Table 3), neither of which were independently associated with retention. We identified 49 low-retention and 53 high-retention matched providers. High-retention providers were still more likely to be PCPs after matching on patient characteristics. High-retention providers' episodes also had fewer BH visits in the first 30 days.

Treatment Experience and Services

We interviewed 10 high-retention and 10 low-retention providers regarding factors that could explain differences in retention. We asked providers about their experience providing buprenorphine treatment and characteristics of their treatment programs that could affect retention. We found differences in motivations for providing treatment between groups. Eight high-retention providers reported that they started prescribing buprenorphine in response to a perceived need for treatment. "I saw a need for it," one provider said, "One of my best friend's

son died of a heroin overdose, which sort of got me particularly interested in it." Four low-retention providers also discussed need, but seven described starting buprenorphine for employment opportunities, professional development, or income.

Providers with more treatment experience may be more skilled in retaining patients in care. However, we found that high-retention providers on average started prescribing buprenorphine more recently than low-retention prescribers (4.5 years vs. 8 years). Both groups on average reported currently treating a similar number of patients (120 high-retention and 110 low-retention).

Providers could have achieved higher retention by offering more comprehensive or intensive services. However, we found eight low-retention providers worked in programs that offered on-site psychosocial services, typically individual or group counseling, compared to only five high-retention providers. Similarly, four low-retention and two high-retention providers reported offering some level of peer support or case management services.

Another possibility is that providers with lower cost services achieved higher retention. Again, however, our results did not support this supposition. Eight low-retention providers accepted Medicaid and private insurance, compared to only five high-retention providers. However, Medicaid did not always pay for counseling services for programs that accepted it, so patients at times had to pay out-of-pocket for these services. One provider explained that weekly counseling was typically required but Medicaid patients could come to counseling less than weekly to minimize costs, "The patients pay out of pocket $25 for the counseling session, and that's why they have to be at the two weeks or four weeks. We don't want to be financial burden for those patients." Some providers that did not accept insurance said that they used sliding-scale fees and adjusted visit frequency to avoid overly burdening patients financially. One provider

who did not accept insurance said, “I do have a sliding scale. From time to time I'll see somebody for $25 a visit if I feel like they're genuinely destitute and they're genuinely trying as hard as they can.”

Clinical Practices

We asked providers about numerous aspects of their clinical practice that could affect retention. Providers could have achieved high patient retention by selecting to treat only stable patients who were likely to adhere to treatment, but we did not find evidence of this. Five low-retention and four high-retention providers said they might not initiate buprenorphine for a patient with co-occurring psychiatric illness, another co-occurring substance use disorder, or lacking social stability. As one provider said, “Most of the time I do not put a person that is homeless or mentally ill [on buprenorphine].” Other providers required only diagnosed OUD and interest in treatment: “That [patients] meet criteria for opioid use disorder and that they would like to try buprenorphine. Those are probably my two criteria.”

Differences in retention could also be driven by high-threshold treatment practices that created barriers to retention. As described above, we counted whether providers used any of five key higher-threshold practices: conducting office or facility-based inductions, requiring psychosocial treatment as part of buprenorphine treatment, discharging patients in response to positive drug screens, discharging patients in response to missed visits, and encouraging shorter treatment duration. We found that both high- and low-retention providers engaged in high-threshold practices, but these practices were more common among low-retention providers. All ten low-retention providers used at least one high-threshold practice, compared to only five out of ten high-retention providers. The average number of high threshold practices was 2.3 in the low-retention group and 1.1 in the high-retention group.

Five low-retention and three high-retention providers required some patients to undergo office or facility-based induction that typically required remaining under clinical observation for several hours. Some providers that required office-based induction said this practice was becoming less frequent, in part because so many patients had previously used buprenorphine illicitly or in treatment. As a provider explained, “I think more and more nowadays we're just letting them take it at home because they have had experience with Suboxone, but if they've never had any experience with Suboxone or they're coming off of methadone, or there's something else that we're concerned about then, we'll watch them for an hour or two.”

Seven low-threshold providers required counseling as part of treatment, compared to four high-threshold providers. Providers that did not require counseling pointed to evidence that it did not improve outcomes and expressed skepticism about the benefit of mandated therapy: “You can't make people do therapy. I mean, that's ridiculous. I mean, therapy's a whole process that requires buy-in.” Providers that required counseling saw it as a crucial component of recovery, at times viewing buprenorphine as the less significant component: “If you just have somebody come to an office and you hand them a [buprenorphine] strip and that's all they get, I don't think that's really helping him. I believe the combination of the group therapy, one on one counseling, the one on one with me, all of that is an important component to getting people better.”

No providers strictly limited treatment to a certain length of time. Six low-retention and two high-retention providers encouraged patients to stop buprenorphine treatment at some point, though they typically emphasized that this was a gradual process: “If they'd been in the program for a while and they appear to be stable on recovery, I start talking to them about, gradually and slowly starting to lean down, but they have to be mentally prepared for that.” The remaining providers flexibly approached treatment length, often emphasizing patients’ choice: “That's an

individual choice… We have a conversation that's based on their goals, and if it's one of their goals to come off [buprenorphine], we work with it. If it's not, then we don't."

Eight low-retention providers reported conducting urine drug screens every visit, compared to only five high-retention providers. Providers generally reported that they responded to positive drug screens by discussing the result with patients and by increasing visit frequency. Three low-retention providers and one high-retention provider mentioned discharge as a possible response to positive urine drug screens.

Providers offered diverging views about the importance of abstinence from non-opioid illicit drug use as a condition for continued treatment. A provider who conducted screening at every visit said regarding positive drug screens: "I'm not going to let you smoke weed and I'm not going to let you do this stuff and say, 'Oh, this is just a little bit better.' So I'm very strict and I have a no tolerance policy in my clinics." By contrast, a provider who individualized screening frequency said: "The reality is, if you test people a lot, a lot of what you find is pot, which I don't care about, or you find out who did a bump of coke at their cousin's bachelor party. You just get a lot of information that is really not super clinically significant." This provider and others generally expressed that patients who frequently used stimulants were particularly challenging to treat.

Nearly all providers reported seeing patients for weekly visits for a time after induction and gradually moving to four- or six-week visits, though there were variations in how long patients remained on weekly visits and what the conditions were for moving to less frequent visits. Some providers made decreasing visit frequency contingent on urine drug screens demonstrating abstinence from all illicit drug use: "So I have folks come in weekly until they pass a urine drug test for all substances. And then they can gain a week up to six weeks."

Differences in retention could also be driven in part by differences in dosing practices. Providers varied in how quickly they increased dosage at initiation, with several reporting that patients were often already on illicit buprenorphine. Six high-retention and two low-retention providers said they asked patients what dosage worked for them: “I'll ask them, historically, how have you taken this? Whether it's a previous healthcare provider has prescribed it or if it's been taken off the street.” Six low-retention providers and three high-retention providers said they did not prescribe more than 16mg of buprenorphine per day for maintenance treatment.

Attitudes and Experiences

Differences in provider attitudes and experiences could inform practices that affect retention. Though high-retention providers were less likely to offer co-located psychosocial services or require counseling, this was not apparently based on lack of appreciation for psychosocial etiology of OUD. When discussing the causes of OUD, six providers in each group emphasized the role of psychosocial factors, including trauma, in combination with opioid exposure: “I think [OUD] is multi-factorial. I think that for a lot of the women that I take care of, the majority, not all, have pretty significant trauma histories. And then they'll have sort of early introduction to use substances.” The remaining providers emphasized opioid exposure, at times mentioning genetic predisposition: “I think genetic vulnerability is always going to be there, but the early exposure from dentists and primary care doctors is killing us. I've had many, many patients who were given opioids for menstrual cramps, or for migraines when they were teenagers.”

The most frequent reasons providers gave for why patients stopped care were recurrent drug use, cost of treatment, other barriers to treatment such as transportation, and stigma, often related to lack of support from family. One provider explained why patients typically stopped treatment, “Financial reasons are one. Maybe they're getting pressure from family members or a

spouse. There's definitely a lot of misinformation out there about [medication treatment].” Though high-retention providers less often accepted insurance, four providers in each group mentioned cost as a reason that patients stopped treatment.

Differences in retention could be driven by patient preferences. Indeed, five low-retention providers and only two high-retention providers mentioned that patients at times stopped treatment because they choose to. However, some providers emphasized that this was a rare occurrence and these patients often returned to drug use. One provider who encouraged shorter treatment length acknowledged the peril of stopping treatment early: “Unfortunately, most of the people that stopped treatment on their own have relapsed, if they stop early. I have had some people who wanted to accelerate and get back into school or yeah get a job as a truck driver or whatever, you know, things that buprenorphine wasn't compatible with.” Patients may be more likely to perceive buprenorphine as incompatible with school or work if they are in a high-threshold practice that leaves less time and flexibility for these pursuits. As a result, high-threshold practitioners may appear to have patients who prefer shorter treatment length.

Finally, high-retention providers may be providers that achieved better therapeutic relationships with their patients. While we could not assess this directly, we noted that five low-retention and three high-retention providers mentioned conflicts or mistrust with patients as challenges of treatment: “Setting limits. Barriers, barriers, barriers. That's the biggest challenge. These are people that are not used to people saying no to them.” Despite these challenges, providers from both groups spoke positively about their experiences providing buprenorphine: “Before I started using buprenorphine and learning about addiction, I didn't know how to relate to these patients, and I didn't know the best way to care for them. And once I learned more about that, it really helped those relationships grow. And I've seen it change people's lives.”

Discussion

There was variation in program resources and treatment practices among high and low-retention providers, suggesting that there are multiple paths to high-retention. Nevertheless, our results suggest that low-threshold approaches help explain higher retention rates among some providers. All low-retention providers used at least one high-threshold practice compared to half of high-retention providers. High-retention providers started prescribing buprenorphine more recently than low-retention providers so may be more informed by recent shifts in recommended practices that emphasize individualization over regimented approaches.[72] We did not find evidence that providers who achieved higher retention consistently did so by providing more comprehensive services, delivering lower-cost care, or selecting for more stable patients. Low-retention providers' patients may prefer shorter treatment lengths, though this preference may be itself a consequence of high-threshold practices.

The fact that high-retention providers less frequently accepted insurance should not be taken to mean cost is not a barrier to treatment, as several providers indicated it was a frequent reason that patients stopped treatment. Patients may be faced with a choice of low-threshold providers at higher costs and high-threshold providers at lower costs. Some patients may choose higher-cost providers who use lower-threshold approaches so they can continue income-generating practices, trading off cost of care with time and flexibility to accommodate work or other activities. Our results raise questions about how providers financially sustain buprenorphine delivery. For providers who accept insurance, and likely receive lower compensation per visit, requiring engagement with psychosocial services may be an important revenue strategy.

There was no single high-threshold practice that appeared to reliably predict retention. That said, required psychosocial visits may be especially important. We found that episodes from

high-retention providers had fewer claims for BH visits even after matching. Not requiring counseling could explain why PCPs and office-based providers were associated with higher retention in claims analyses, since these providers may be less likely to have on-site psychosocial services. We could not determine if offering psychosocial services without requiring them might improve retention since low-retention providers more often offered and required them. Other provider practices such as conducting frequent drug testing and limiting buprenorphine dosage also may have contributed to differences in retention rates. We found that low-retention providers' episodes had lower average doses and more drug screens than high-retention providers' episodes, but these differences were not statistically significant.

We found large differences in probability of retention by patient race and ethnicity, even when controlling for co-morbidities and prior health service use. According to providers, treatment cost, logistical barriers such as transportation, and stigma were important reasons for why patients left treatment early. These factors likely differentially affect racial and ethnic groups. Providers may also be more likely to discharge these patients because of discrimination or implicit biases that have been documented in other areas of medicine.[105] Patients who had previous opioid poisoning services, schizophrenia services, and ED visits were less likely to reach 180-day retention, possibly because these patients had more severe SUDs or more complex psychosocial needs. Interestingly, patients with more prior specialty SUD visits were more likely to be retained, possibly reflecting patients' stages of recovery. The finding that female patients had better retention than male patients is consistent with previous research finding that women have better outcomes in OUD treatment than men.[106]

Predicted probabilities from our regression models performed poorly in predicting retention. This result suggests retention that is likely driven by factors that are not easily

observed in secondary data, such as high-threshold treatment practices and patient barriers to treatment like cost and transportation. This finding points to the importance of mixed-methods studies such as this one. Our study demonstrates an approach to investigating provider practices that could be driving patient outcomes while accounting for differences in patient characteristics between providers.

Our study was limited to capturing data from NC Medicaid enrollees, so we could not observe outcomes for non-Medicaid individuals. For providers who did not accept Medicaid, we may have underestimated their rates retention for all patients, since low-income Medicaid patients may have faced higher costs for care compared to other patients. That said, we found more of these providers in the high-retention group, so this underestimation would not change the direction of our findings. Our study was also limited in that we could not interview patients, so we presented providers' perspective on why patients were not retained in treatment. We also cannot be certain that the interview results are representative of the groups samples.

Our study suggests low-threshold approaches to treatment contribute to higher retention, but that other factors, such as treatment cost, are also likely involved in determining retention. Strategies to reduce the time and logistical burden of buprenorphine treatment for patients while serving patients' psychosocial needs could hold promise for improving retention.

Table 5. Patient, Provider and Treatment Episode Characteristics by 180-Day Retention

	Not Retained (4115)	Retained (3841)	p-value
Patient demographics			
Age	35 (10)	35 (9.6)	0.16
Female	2956 (72%)	2952 (77%)	<0.001
Race			
White	3385 (82%)	3319 (86%)	<0.001
Black	379 (9.2%)	206 (5.4%)	
Asian	5 (.12%)	3 (.078%)	
Two or more	23 (.56%)	27 (.7%)	
Unknown	323 (7.8%)	286 (7.4%)	
Ethnicity			
Not Hispanic	3839 (93%)	3670 (96%)	<0.001
Hispanic	54 (1.3%)	31 (.81%)	
Unknown	222 (5.4%)	140 (3.6%)	
Rural	1224 (30%)	1303 (34%)	<0.001
Co-morbidities (pre 12 month)			
Opioid overdose	579 (14%)	340 (8.9%)	<0.001
Depression	2927 (71%)	2712 (71%)	0.61
Anxiety	3168 (77%)	3013 (78%)	0.12
Bipolar disorder	1474 (36%)	1266 (33%)	0.007
Schizophrenia	597 (15%)	386 (10%)	<0.001
Alcohol use disorder	1156 (28%)	900 (23%)	<0.001
Other substance use disorder	3490 (85%)	3258 (85%)	0.99
HIV	43 (1%)	24 (.62%)	0.040
Hepatitis C	789 (19%)	637 (17%)	0.003
Chronic pain	3505 (85%)	3216 (84%)	0.089
Diabetes	864 (21%)	787 (20%)	0.58
Chronic obstructive pulmonary disease	1125 (27%)	1030 (27%)	0.60
Coronary artery disease	296 (7.2%)	219 (5.7%)	0.007
Healthcare Use (pre 12 month)			
Specialty SUD visits	14 (47)	17 (57)	0.004
Behavioral health visits	3.7 (9.9)	3.5 (8.1)	0.34
Emergency visits	3.5 (5.7)	2.7 (4.1)	<0.001
Inpatient psych stays	.41 (2.9)	.26 (3.1)	0.030
Inpatient med stays	.34 (1.8)	.25 (2.4)	0.064
Buprenorphine prescriber			
Specialty			
Primary care	1919 (47%)	1934 (50%)	<0.001
Behavioral health	1458 (35%)	1275 (33%)	
Pain	509 (12%)	371 (9.7%)	
Other	229 (5.6%)	261 (6.8%)	
Addiction Specialist	974 (23.7%)	854 (22.2%)	0.13
Setting			
Office	2918 (70.9%)	2808 (73.1%)	<0.001
Hospital	305 (7.4%)	190 (4.9%)	
Behavioral health center	623 (15.1%)	535 (13.9%)	

Federally qualified health center	166 (4.0%)	177 (4.6%)	
Other	33 (0.8%)	56 (1.5%)	
Unknown	70 (1.7%)	75 (2.0%)	
Patient-centered medical home	1761 (43%)	1733 (45%)	0.037
Rural	610 (15%)	676 (18%)	<0.001
Female	1169 (28%)	973 (25%)	0.002
Days prescribing buprenorphine (100 days)	8.7 (3.7)	8.8 (3.6)	0.17
Patients treated (100 patients)	1.1 (1.1)	1 (.99)	0.024
Episode characteristics[a]			
Starting daily dose (mg)	14 (8.7)	15 (6.5)	<0.001
Visit frequency 30 day	3.3 (3.5)	3.2 (3.2)	0.56
Tox frequency 30 day	2.5 (2.8)	2.7 (2.9)	0.005
BH visit frequency 30 day	1.9 (3.6)	1.6 (3.3)	0.003

[a] Starting daily dose is the daily dose for the first buprenorphine prescription of the treatment episode. E&M visit frequency, toxicology frequency, and BH visits is the number of visits or tests in the first 30 days of an episode for episodes that lasted at least 30 days.

Table 6. Association of Patient and Provider Characteristics with 180-Day Retention

	Patient model	Provider model	Combined model
Patient characteristics			
Age	0.00079		0.00078
	[-0.00051,0.0021]		[-0.00051,0.0021]
Female	**0.052*** **		**0.052*** **
	[0.026,0.078]		**[0.026,0.078]**
Race (white ref)			
Black	**-0.11*** **		**-0.11*** **
	[-0.15,-0.067]		**[-0.15,-0.064]**
Asian	-0.053		-0.049
	[-0.39,0.29]		[-0.39,0.29]
Two or more	0.081		0.079
	[-0.055,0.22]		[-0.056,0.21]
Unknown	-0.036		-0.029
	[-0.079,0.0076]		[-0.072,0.014]
Ethnicity (not Latino ref)			
Latino	**-0.11***		**-0.11***
	[-0.21,-0.0097]		**[-0.21,-0.011]**
Unknown	**-0.065***		**-0.065***
	[-0.12,-0.012]		**[-0.12,-0.013]**
Rural	0.025		0.020
	[-0.0019,0.052]		[-0.0074,0.048]
Comorbidities			
Opioid poisoning	**-0.090*** **		**-0.089*** **
	[-0.12,-0.056]		**[-0.12,-0.055]**
Depression	0.0041		0.0048
	[-0.022,0.030]		[-0.021,0.031]
Anxiety	0.022		0.020
	[-0.0068,0.051]		[-0.0084,0.049]
Bipolar disorder	-0.024		-0.025*
	[-0.049,0.00068]		[-0.049,-0.00027]
Schizophrenia	**-0.054** **		**-0.052** **
	[-0.090,-0.018]		**[-0.088,-0.017]**
Alcohol use disorder	-0.021		-0.021
	[-0.047,0.0047]		[-0.047,0.0048]
Other substance use disorder	0.018		0.016
	[-0.013,0.049]		[-0.015,0.047]
HIV infection	-0.035		-0.039
	[-0.16,0.089]		[-0.16,0.083]
HCV infection	-0.023		-0.022
	[-0.052,0.0064]		[-0.051,0.0064]
Chronic pain	-0.0035		-0.0043
	[-0.035,0.028]		[-0.035,0.026]
Diabetes	0.028		0.028
	[-0.00075,0.056]		[-0.00036,0.056]
COPD	0.018		0.018
	[-0.0084,0.045]		[-0.0079,0.045]
CAD	-0.014		-0.015
	[-0.062,0.033]		[-0.062,0.032]

Healthcare use			
Specialty SUD visits	**0.00030****		**0.00031****
	[0.000083,0.00052]		**[0.000096,0.00052]**
BH visits	0.00045		0.00053
	[-0.00084,0.0017]		[-0.00074,0.0018]
Emergency department visits	**-0.0059*****		**-0.0057*****
	[-0.0085,-0.0033]		**[-0.0083,-0.0031]**
Inpatient psychiatric stays	-0.0039		-0.0045
	[-0.013,0.0050]		[-0.013,0.0043]
Inpatient medical stays	0.0051		0.0060
	[-0.0070,0.017]		[-0.0061,0.018]
Provider Characteristics			
Provider specialty (PCP ref)			
BH specialist		**-0.069****	**-0.069****
		[-0.12,-0.021]	**[-0.12,-0.022]**
Pain specialist		**-0.10****	**-0.095***
		[-0.18,-0.024]	**[-0.17,-0.017]**
Other provider		-0.0093	-0.0044
		[-0.088,0.069]	[-0.082,0.074]
Female		-0.036	-0.037
		[-0.080,0.0078]	[-0.081,0.0066]
Setting (office ref)			
Hospital		**-0.13*****	**-0.12*****
		[-0.20,-0.067]	**[-0.19,-0.051]**
BH center		-0.0077	0.00014
		[-0.064,0.049]	[-0.056,0.057]
FQHC		0.0024	0.021
		[-0.080,0.085]	[-0.061,0.10]
Other setting		0.12	0.11
		[-0.030,0.26]	[-0.038,0.25]
Unknown		-0.0092	-0.013
		[-0.12,0.099]	[-0.12,0.094]
Addiction specialist		-0.00044	0.00065
		[-0.056,0.055]	[-0.054,0.056]
PCMH		-0.031	-0.032
		[-0.075,0.013]	[-0.076,0.012]
Rural		**0.060***	0.040
		[0.0066,0.11]	[-0.015,0.095]
Days providing buprenorphine (100)		-0.00041	-0.0013
		[-0.0049,0.0041]	[-0.0058,0.0032]
Patients treated (100)		-0.015	-0.012
		[-0.040,0.010]	[-0.037,0.013]
Observations	7953	7956	7953

Marginal effects are presented with 95% confidence interval from delta method standard errors.

Table 7. Patient Characteristics of Matched High- and Low-Retention Providers

	Low-retention (49 providers)	High-retention (53 providers)	p-value
Retention rate	.23 (.17)	.81 (.14)	<0.001
Patient Demographics[1]			
Age	34 (5.8)	36 (6.5)	0.092
Female	.8 (.22)	.74 (.26)	0.23
Black	.031 (.054)	.027 (.059)	0.70
Latino	.0087 (.022)	.0032 (.012)	0.13
Rural	.36 (.35)	.3 (.37)	0.40
	Low-retention (49 providers)	**High-retention (53 providers)**	
Patient Comorbidities[2]			
Opioid overdose	.08 (.15)	.071 (.15)	0.78
Depression	.66 (.27)	.66 (.27)	0.95
Anxiety	.69 (.28)	.8 (.22)	0.036
Bipolar	.29 (.27)	.3 (.27)	0.97
Schizophrenia	.076 (.15)	.065 (.15)	0.71
Alcohol use disorder	.21 (.25)	.18 (.19)	0.51
Other substance use disorder (%)	.77 (.27)	.75 (.29)	0.81
HIV infection	.0087 (.032)	.0021 (.0092)	0.16
HCV infection	.13 (.21)	.14 (.21)	0.87
Chronic pain	.71 (.31)	.82 (.26)	0.048
Diabetes	.2 (.28)	.24 (.3)	0.54
Chronic obstructive pulmonary disease	.22 (.25)	.25 (.24)	0.55
Coronary artery disease	.067 (.16)	.041 (.089)	0.31
	Low-retention (49 providers)	**High-retention (53 providers)**	
Healthcare use[3]			
Specialty SUD visits	7.3 (17)	5.6 (15)	0.60
BH visits	2.4 (2.7)	2.8 (4.3)	0.59
Emergency visits	2 (1.4)	2 (1.2)	0.89
Inpatient psych stays	.11 (.22)	.58 (3.4)	0.34
Inpatient med stays	.19 (.32)	.21 (.43)	0.77
	Low-retention (49 providers)	**High-retention (53 providers)**	
Provider characteristics[4]			
Specialty			
Primary care	25 (51%)	35 (66%)	0.064
BH specialist	23 (47%)	14 (26%)	
Other provider	1 (2%)	4 (7.5%)	
Addiction specialist	6 (12%)	2 (3.8%)	0.11
Setting			
Office	25 (51%)	28 (53%)	0.37
Hospital	6 (12%)	3 (5.7%)	
Behavioral health center	10 (20%)	9 (17%)	
Federally qualified health center	5 (10%)	3 (5.7%)	

Other	1 (2%)	4 (7.5%)	
Unknown	2 (4.1%)	6 (11%)	
Patient-centered medical home	22 (45%)	21 (40%)	0.59
Female	18 (37%)	16 (30%)	0.48
Rural	7 (14%)	13 (25%)	0.19
Days prescribing buprenorphine (100 days)	7.1 (4.2)	6.1 (4.4)	0.23
Patients treated (100 patients)	.42 (.77)	.24 (.41)	0.14
	Low-retention (49 providers)	**High-retention (53 providers)**	
Episode characteristics[5]			
Starting daily dose (mg)	14 (6.8)	15 (5.3)	0.51
Visit frequency 30 day	2.8 (3)	2.3 (2.2)	0.30
Tox frequency 30 day	2 (2.1)	1.7 (1.3)	0.44
BH visit frequency 30 day	2.1 (3.2)	1.1 (2.1)	0.062

[1] Average age of providers' patients and proportion of patients who are female, Black, Latino, and live in rural counties.

[2] Proportion of patients who had a non-diagnostic service claims for each condition in the 12-months before start of buprenorphine treatment.

[3] Average number of healthcare visits or stays in the 12 months prior to the start of a buprenorphine treatment episode

[4] Summary statistics of buprenorphine prescribers in the high and low retention groups.

[5] Summary statistics of starting daily buprenorphine dose, number of provider visits, number of toxicology tests, and number of behavioral health visits in the first 30 days of treatment for episodes lasting at least 30 days.

CONCLUSION

Our results give reason for hope and concern regarding access and quality of OAT in Medicaid. In Chapter 1, we found a promising trend of increasing methadone and buprenorphine in expansion and non-expansion states. However, we did not find evidence that expansion increased methadone dispensed in states, suggesting improvements in coverage have not translated to improvements in access. We found that expansion only increased buprenorphine in states with the most waivered providers. This result suggests OAT provider capacity constraints are one factor limiting access to treatment even when coverage improves.

These results point to importance of adopting policies to increase the supply of OAT providers. A promising approach may be to bring federal regulations of OAT in line with approaches from other high-income countries. The United States could allow office-based prescription of methadone for OUD and do away with the waiver requirement for buprenorphine prescription for OUD.[54,63] States could increase the number of OAT providers accepting Medicaid by removing administrative barriers in Medicaid such as prior authorization and increasing reimbursement.[107] Even if these policies are adopted, several other barriers to OAT implementation will likely remain, such as lack of training and psychosocial services.[55] A sustained longitudinal policy approach is necessary to ensure there are enough SUD providers to meet demand.

Our Chapter 2 results mirror the results from Chapter 1 using data from North Carolina Medicaid. We found that while the number of enrollees receiving OAT increased between 2014

and 2017, the percent of people with OUD receiving OAT remained stable, again suggesting that treatment supply may not be keeping up with demand. On the encouraging side, we found that quality of treatment has been consistently improving. This result suggests that efforts to improve treatment access through office-based and primary care providers are not coming at the cost of treatment quality. States should continue these policy approaches.

Despite these promising findings, we note that measuring quality of OUD treatment is challenging. We measured quality in part as adherence to treatment guidelines. However, there is increasing appreciation for the fact that treatment should be individualized.[72] We constructed our guideline-adherence measures to focus on practices that are always recommended, such as HIV testing, and to reflect minimum suggestions for practice, such as at-least-monthly office visits. We also measured quality as treatment retention, which is increasingly recognized as an important outcome.[30] However, retention could be a reflection of patient- or provider-level factors. There is a need for information on what providers can do to improve retention.

In Chapter 3 we sought to understand patient- and provider-level drivers of treatment retention. We first examined patient and provider characteristics associated with low retention. Not surprisingly, patients who appeared to have more severe OUD based on service use or had significant psychiatric comorbidities were less likely to achieve 180-day treatment retention. We also found large racial and ethnic disparities in treatment retention. These results confirm the importance of patient characteristics in driving retention. These associations persisted even when we controlled for provider-level factors. Interestingly, we found PCPs had higher retention than BH or pain specialists even after controlling for patient characteristics. These results suggest provider-level differences are partially driving differences in retention.

We developed a novel mixed-methods approach to understand provider-level factors that could drive retention while accounting for differences in patient characteristics. We created groups of high- and low-retention providers matched on patient characteristics that could be used for purposeful interview sampling. We interviewed providers on a broad set of topics that could drive retention. We found that high-retention providers used more flexible and less restrictive approaches to treatment. High-retention providers less often required patients to engage in psychosocial treatment and less often discharged patients for noncompliance. We did not find evidence that providers who achieved higher retention consistently did so by providing more comprehensive services, delivering lower-cost care, or selecting for more stable patients. Our findings suggest easing restrictive treatment policies could improve retention in care.

This dissertation demonstrates the importance of rigorous research evidence for informing policy and clinical practices in addressing persistently high opioid overdose death rates. Our findings offer opportunities for future work to inform policy to increase access and quality of OUD treatment. Examining in detail OAT provider networks in Medicaid and private insurance using geospatial approaches could provide insights into why increasing in health coverage are not translating to increases in treatment access. This research could combine data sources to identify waivered providers, determine whether these providers actively prescribe buprenorphine, and determine if providers accept Medicaid or private insurance.

Another promising area for future study is examining the effect of Medicaid policies on OAT quality. We found evidence in Chapter 2 that a North Carolina Medicaid policy to limit payments for urine drug testing likely decreased testing frequency. This change could have affected providers' ability to detect illicit drug use, which could translate to changes in treatment retention and even overdose probability. Using a mixed-methods approach to investigate the

effect of this policy on provider practices and treatment outcomes could provide valuable insights for policymaking and clinical practice.

Finally, Chapter 3 suggests that adopting more flexible and less restrictive treatment approaches could improve patients' retention in treatment. We could extend this research by surveying large groups of providers on use of restrictive treatment practices and testing the association between specific practices and providers' patient retention. We could also test restrictive treatment approaches against more flexible approaches in a trial approach, or test interventions to encourage providers to ease restrictions on treatment. These future research opportunities will build on the findings and insights from the present study.

APPENDIX 1: CPT CODES AND PRESCRIBER CHARACTERISTICS

Table A1. CPT Codes for North Carolina Medicaid Services

E&M codes	
Generic E&M	99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, 99215, 99304, 99305, 99306, 99307, 99308, 99309, 99310, 99318, 99324, 99325, 99326, 99327, 99328, 99334, 99335, 99336, 99337, 99341, 99342, 99343, 99344, 99345, 99347, 99348, 99349, 99350, G0402, G0438, G0439
Psychiatric E&M	90805,90807,90809,90811,90813,90815, 90862,
SUD services that can include medication management visits	H0013, H0015, H0020, H2035
BH evaluation or treatment	90791, 90792, 90801, 90802, 90804, 90805, 90806, 90807, 90808, 90809, 90810, 90811, 90812, 90813, 90814, 90815, 90816, 90817, 90818, 90819, 90821, 90822, 90823, 90824, 90826, 90827, 90828, 90829, 90832, 90833, 90834, 90836, 90837, 90838, 90839, 90840, 90845, 90846, 90847, 90849, 90851, 90853, 90857, 90862, 90863, 90875, 90876, 96101, 96102, 96103, 96116, 96118, G0409, G0410, G0411, H0001, H0002, H0003, H0004, H0005, H0012, H0013, H0015, H0032, H0035, H0040, H2015, H2017, H2022, H2035, T1023
Toxicological testing	80300, 80301, 80302, 80303, 80304, 80320, 80321, 80322, 80323, 80324, 80325, 80326, 80327, 80328, 80329, 80330, 80331, 80332, 80333, 80334, 80335, 80336, 80337, 80338, 80339, 80340, 80341, 80342, 80343, 80344, 80345, 80346, 80347, 80348, 80349, 80350, 80351, 80352, 80353, 80354, 80355, 80356, 80357, 80358, 80359, 80360, 80361, 80362, 80363, 80364, 80365, 83992, 80366, 80367, 80368, 80369, 80370, 80371, 80372, 80373, 80374, 80375, 80376, 80377, G0477, G0478, G0479, G0480, G0481, G0482, G0483
HIV testing	87901, 87906, 86689, 86701, 86702, 86703, 87389, 87390, 87391, 87534, 87535, 87536, 87537, 87538, 87539, 87806, G0432, G0433, G0435
HCV testing	80074, 86803, 86804, 87520, 87521, 87522, 87902

Table A2. Buprenorphine Prescriber Characteristics by Specialty

	PCPs (490)	BH providers (275)	Pain specialists (39)	Other providers (89)	p-value
Addiction specialist	31 (6.3%)	48 (18%)	5 (13%)	4 (4.5%)	<0.001
Total days prescribing buprenorphine in study period	726 (672)	975 (733)	1200 (703)	561 (640)	<0.001
Total patients treated with buprenorphine in study period	29 (66)	36 (67)	70 (110)	21 (44)	<0.001
Female	232 (47%)	87 (32%)	3 (7.7%)	33 (37%)	<0.001
Rural	84 (17%)	38 (14%)	10 (25%)	10 (11%)	0.13
PCMH	272 (55%)	55(20%)	9 (23%)	20 (22%)	<0.001
Setting					
Office	262 (54%)	90 (33%)	28 (72%)	35 (39%)	<0.001
Hospital	62 (13%)	48 (18%)	6 (15%)	23 (26%)	
BH center	24 (4.9%)	86 (31%)	1 (2.6%)	6 (6.7%)	
FQHC	72 (15%)	7 (2.5%)	0 (0.0%)	2 (2.2%)	
Other	19 (3.9%)	8 (2.9%)	0 (0.0%)	6 (6.7%)	
Unknown	51 (10%)	36 (13%)	4 (10%)	17 (19%)	

For continuous variables, means are presented with standard deviations in parentheses and p-values from ANOVA tests. For binary and categorical variables, counts are presented with percentages in parenthesis and p-values from chi-squared tests.

APPENDIX 2: CODES

Healthcare use	Codes
ED visit	CPT: 99281, 99282, 99283, 99284, 99285, G0380, G0381, G0382, G0383, G0384 OR revenue code: 0450, 0451, 0452, 0456, 0459
Inpatient psychiatric visit	DRG: 0876, 0880, 0881, 0882, 0883, 0884, 0885, 0886, 0887, 0894, 0895, 0896, 0897 OR revenue code: 0114, 0124, 0134, 0144, 0154, 0204, 1001
Inpatient medical visit	Revenue code: 0111, 0112, 0113, 0114, 0115, 0116, 0117, 0118, 0119, 0121, 0122, 0123, 0125, 0126, 0127, 0128, 0129, 0130, 0131, 0132, 0133, 0135, 0136, 0137, 0138, 0139, 0140, 0141, 0142, 0143, 0145, 0146, 0147, 0148, 0149, 0150, 0151, 0152, 0153, 0155, 0156, 0157, 0158, 0159, 0160, 0164, 0167, 0169, 0200, 0201, 0202, 0203, 0205, 0206, 0207, 0208, 0209, 0210, 0211, 0212, 0213, 0214, 0219
Specialty substance use visit	CPT: H0010, H0012, H0013, H0014, H0015, H0020, H2035, H2036
BH visit	CPT: 96101, 96102, 96103, 96116, 96118, G0409, G0410, G0411, H0036, H0037, S9480, 90791, 90792, 90801, 90802, 90804, 90805, 90806, 90807, 90808, 90809, 90810, 90811, 90812, 90813, 90814, 90815, 90816, 90817, 90818, 90819, 90821, 90822, 90823, 90824, 90826, 90827, 90828, 90829, 90832, 90833, 90834, 90836, 90837, 90838, 90839, 90840, 90845, 90846, 90847, 90849, 90851, 90853, 90857, 90862, 90863, 90875, 90876, G0409, G0410, G0411, H0002, H0004, H0032, H0035, H0040, H0046, H2011, H2015, H2017, T1023
E&M visit	99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, 99215, 99304, 99305, 99306, 99307, 99308, 99309, 99310, 99318, 99324, 99325, 99326, 99327, 99328, 99334, 99335, 99336, 99337, 99341, 99342, 99343, 99344, 99345, 99347, 99348, 99349, 99350, G0402, G0438, G0439
Toxicology screen	CPT: 80300, 80301, 80302, 80303, 80304, 80320, 80321, 80322, 80323, 80324, 80325, 80326, 80327, 80328, 80329, 80330, 80331, 80332, 80333, 80334, 80335, 80336, 80337, 80338, 80339, 80340, 80341, 80342, 80343, 80344, 80345, 80346, 80347, 80348, 80349, 80350, 80351, 80352, 80353, 80354, 80355, 80356, 80357, 80358, 80359, 80360, 80361, 80362, 80363, 80364, 80365, 83992, 80366, 80367, 80368, 80369, 80370, 80371, 80372, 80373, 80374, 80375, 80376, 80377, G0477, G0478, G0479, G0480, G0481, G0482, G0483

APPENDIX 3: INTERVIEW GUIDE

Part 1. Provider Characteristics – knowledge and motivation

- How long have you been prescribing buprenorphine for opioid use disorder?
- Why did you start prescribing buprenorphine for opioid use disorder?
- Have you used any training materials or educational resources to help you provide buprenorphine treatment? If so, what have you used?
- Have you used any other resources or participated in any programs to help you provide buprenorphine treatment? If so, what have you used?
- How many patients with opioid addiction are you currently treating with buprenorphine?

Part 2. Program Characteristics

- Other than buprenorphine prescribing, what services does your clinic or program offer as part of treatment of opioid use disorder?
    - Does your clinic or program offer any behavioral health or recovery services (such as peer support, mutual aid groups, group therapy, individual counseling) as part of treatment? If so, what do you offer?
    - Does your clinic or program offer any social support services (such as support with housing, nutrition, childcare, or criminal justice involvement) as part of treatment? If so, what do you offer?

Part 3. Implementation Characteristics

- How do you determine if a patient is a good candidate for buprenorphine treatment?
- What is your approach to starting a patient on buprenorphine?
- How do you determine patients' buprenorphine dosages?
    - Do you limit initial dosage to a certain range? If so, what?
    - Do you limit maintenance dosage to a certain range? If so, what?
- How frequently do you have patients prescribed buprenorphine come in for visits?
    - How do you respond if a patient misses a visit?
- Is participation in therapy or other psychosocial treatment required at any stage of treatment?
- What is your approach to drug screening for patients prescribed buprenorphine?
    - Do you conduct regular drug screening? How often?
    - Do you conduct random drug screening? How often?
- How do you respond if a patient on buprenorphine has a positive drug screen for opioids?
    - How do you respond if a patient on buprenorphine has a positive drug screen for an illicit drug that is not an opioid?
- How do you determine how long a patient should be on buprenorphine?
    - Do you limit treatment length to a certain time?
- Could you describe your approach to discharging patients?
    - Under what conditions do you discharge patients?
- How do you determine if buprenorphine treatment is successful or it's working?
- What role do treatment guidelines play in your approach to buprenorphine treatment?

Part 4. Provider characteristics - attitudes

- What causes opioid use disorder in your opinion?
- How effective do you find buprenorphine to be in treating opioid use disorder?
- In your experience, why do patients typically stop treatment with buprenorphine?
- How would you describe your experience providing buprenorphine treatment?
- What challenges have you encountered in providing buprenorphine treatment?

Part 5. Wrap up

- Is there anything about your approach to treatment with buprenorphine that we didn't talk about but that you think is important?
- Is there anything about your experience prescribing buprenorphine that we didn't talk about but that you think is important?
- What forms of insurance do you accept for buprenorphine treatment?
    - Medicaid? Private insurance? Medicare? Cash-only?
    - Are there out of pocket costs for Medicaid patients?

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