Massachusetts Health Reform's Effect on Hospitalizations with Substance Use Disorder–Related Diagnoses

Karen E. Lasser, Amresh D. Hanchate , Danny McCormick, Alexander Y. Walley, Richard Saitz, Meng-Yun Lin, and Nancy R. Kressin

Objective. To examine whether Massachusetts (MA) health reform affected substance (alcohol or drug) use disorder (SUD)–related hospitalizations in acute care hospitals.

Data/Study Setting. 2004–2010 MA inpatient discharge data.

Design. Difference-in-differences analysis to identify pre- to postreform changes in age- and sex-standardized population-based rates of SUD-related medical and surgical hospitalizations, adjusting for secular trends.

Data Extraction Methods. We identified 373,751 discharges where a SUD-related diagnosis was a primary or secondary discharge diagnosis.

Findings. Adjusted for age and sex, the rates of drug use–related and alcohol use–related hospitalizations prereform were 7.21 and 8.87 (per 1,000 population), respectively, in high-uninsurance counties, and 8.58 and 9.63, respectively, in low-uninsurance counties. Both SUD-related rates increased after health reform in high- and low-uninsurance counties. Adjusting for secular trends in the high- and low-uninsurance counties, health reform was associated with no change in drug- or alcohol-related hospitalizations.

Conclusions. Massachusetts health reform was not associated with any changes in substance use disorder–related hospitalizations. Further research is needed to determine how to reduce substance use disorder–related hospitalizations, beyond expanding insurance coverage.

Key Words. Health reform, substance use

Substance (alcohol or drug) use disorders are a major public health problem in the United States, causing significant morbidity and mortality. Alcohol use disorders contribute to 88,000 deaths annually in the United States while drug use disorders account for more than 40,000 deaths per year (Mack 2013). Although in clinical practice mental health (including alcohol and drug use)

disorders are often termed *behavioral* health conditions, substance use disorders are closely linked to *physical* illnesses, serving as a risk factor and often preventing adherence to the treatment of such illnesses. Few persons with substance use disorders receive needed treatment; according to the Substance Abuse Mental Health Services Administration, 6.3 percent of people with alcohol use disorders and 13.4 percent of people with drug use disorders received treatment in 2013. One factor that contributes to this “treatment gap” is a lack of health care coverage (SAMHSA 2010).

Health insurance reform is one potential means of addressing the treatment gap. In Andersen’s model of health services utilization for vulnerable populations (Gelberg, Andersen, and Leake 2000), health insurance is an enabling factor to promote health behaviors (e.g., primary care and mental health visits) that in turn produces improved health outcomes. National health reform has included substance use disorder services among the essential benefits provided to U.S. residents who were insured through public, but not employer-based, insurance plans. In addition, the Affordable Care Act (ACA) extended health insurance coverage to populations with high behavioral health needs through Medicaid expansions. Expanded insurance coverage, in turn, can enable access to outpatient and inpatient substance use disorder treatments. Insurance coverage also provides access to effective pharmacotherapies such as naltrexone for treating alcohol use disorder and methadone and buprenorphine for treating opioid use disorder (O’Connor, Sokol, and D’Onofrio 2014).

Massachusetts (MA) health reform served as the template for the ACA. While the ACA’s insurance expansion began in January 2014, MA implemented its expansion in 2006–2007. Thus, MA’s experience may inform how

Address correspondence to Karen E. Lasser, M.D., M.P.H., Section of General Internal Medicine, Boston University School of Medicine, Boston, MA 02118, and Department of Community Health Sciences, Boston University School of Public Health, Boston, MA; e-mail: karen.lasser@bmc.org. Amresh D. Hanchate, Ph.D., is with VA Boston Healthcare System, Boston, MA, and Section of General Internal Medicine, Boston University School of Medicine, Boston, MA. Danny McCormick, M.D., M.P.H., is with the Harvard Medical School, Department of Medicine, Cambridge Health Alliance, Cambridge, MA. Alexander Y. Walley, M.D., M.Sc., is with the Section of General Internal Medicine, Boston University School of Medicine, Boston, MA. Richard Saitz, M.D., M.P.H., is with the Section of General Internal Medicine, Boston University School of Medicine, Boston, MA, and Department of Community Health Sciences, Boston University School of Public Health, Boston, MA. Meng-Yun Lin, M.P.H., is with the Section of General Internal Medicine, Boston University School of Medicine, Boston, MA, and Department of Health Law, Policy & Management, Boston University School of Public Health, Boston, MA. Nancy R. Kressin, Ph.D., is with VA Boston Healthcare System, Boston, MA, and the Section of General Internal Medicine, Boston University School of Medicine, Boston, MA.

future national coverage expansions might affect access to and use of substance use disorder treatment. Other policy initiatives that increased substance use treatment budgets, and hence had the potential to improve access to care, occurred following the implementation of MA health reform. For example, funding for treating substance use disorders came from increases in the budget of the MA Bureau of Substance Abuse Services, the federal Substance Abuse Prevention and Treatment Block Grant, and state general appropriations (NASADAD 2010). In 2006, state and federal monies were earmarked for substance use treatment in order to address increased demand for services created by expanded insurance coverage. According to Capoccia et al. (2012), in fiscal year 2009, the MA Bureau of Substance Abuse Services spent about \$125 million for addiction prevention and treatment. The federal Substance Abuse Prevention and Treatment Block Grant provided \$35 million dollars of this money, while a state appropriation provided \$90 million for uncovered services and to treat the uninsured.

A prior study (Meara et al. 2014) focusing on young adults in MA age 19–25, a group with high behavioral health needs and low rates of insurance coverage prior to reform, found that there was a significant decline (relative to other states) in inpatient admissions and emergency department visits for substance use disorders. However, in a mixed-methods study, Capoccia et al. (2012) documented that utilization of substance use disorder treatment services did not increase 2 years after the MA reform. In the study, the percentage of uninsured patients with substance use disorders in MA remained high. Further, Capoccia et al. (2012) found that large copayments for substance use disorder treatment were a barrier to obtaining treatment.

Prior studies have not examined changes in acute care medical and surgical discharges for substance use disorder–related conditions (as either a primary or secondary diagnosis) among adults under the age of 65, who were most affected by MA health reform. We evaluated whether the insurance expansion had differential effects on substance use disorder–related acute medical and surgical hospitalizations according to geographically varying baseline uninsurance rates within MA, among adults age 18–64. We performed the analysis on regions with geographically varying baseline uninsurance rates in order to isolate the population most affected by health reform: previously uninsured individuals who gained insurance under the reform.

We hypothesized that MA health reform would result in a small decline in substance use disorder–related acute hospitalizations. Our prior work examining the impact of MA health reform on access to outpatient care has shown slight improvements or no change in a number of other outcomes

following reform, including 30-day readmission (Lasser et al. 2014), hospitalizations for ambulatory care-sensitive conditions (McCormick et al. 2015), and procedure use (Hanchate et al. 2015). In the current study, we consider acute hospitalizations for substance use disorder-related diagnoses to be ambulatory care sensitive (i.e., such hospitalizations are potentially preventable with good access to outpatient care [Bindman et al. 1995; Stryjewski et al. 2014] in this case, substance use disorder treatment). We anticipated that, as with these other outcomes, insurance expansion would prove to be a necessary but insufficient factor to produce substantial improvements in substance use disorder-related outcomes. Simpson's conceptual framework for drug treatment process and outcomes (Simpson 2004) highlights the importance of patient attributes (readiness and addiction severity) and program attributes (resources, staff, and climate) that are necessary to promote engagement in treatment and recovery. In addition, social support systems are needed to sustain recovery. MA health reform would have affected neither patient nor program attributes nor social support systems. Thus, we would expect only a modest impact of MA health reform on substance use disorder-related acute hospitalizations.

METHODS

Design Overview

To examine MA reform's effects on substance use disorder-related hospitalizations, we compared changes in population-based rates of such hospitalizations among adults age 18–64 residing in counties with high versus low baseline uninsurance in the prereform period. We used a difference-in-differences design to identify the postreform change adjusted for secular changes unrelated to reform (e.g., differences between two groups, over time) (Hanchate et al. 2012; Joynt et al. 2012; Sommers, Baicker, and Epstein 2012; Dimick and Ryan 2014).

The difference-in-differences method is often used to estimate the impact of a policy intervention (e.g., health reform) on an outcome (e.g., hospitalization where a substance use disorder-related diagnosis is a primary or secondary discharge diagnosis) by computing a double difference. One difference is over time (before-after) and the other is across subgroups of reform beneficiaries (MA residents age 18–64 in high- vs. low-uninsurance counties prereform) (Ryan, Burgess, and Dimick 2015). Because preintervention trends in the outcome variable and characteristics that may be

associated with changes in the outcome variable may differ between groups, it is necessary to control for these factors to isolate the change associated with health reform.

Data

We used all-payer inpatient discharge data from MA (Boston: Division of Health Care Finance and Policy 2009). These data include all non-federal short-term acute care hospitals; inpatient psychiatric and addiction treatment facilities are not included in the dataset. Using 2004–2010 data, we examined adult acute medical and surgical hospitalizations with a primary or secondary discharge diagnosis associated with a substance use disorder (drug- or alcohol-related conditions). We excluded discharges with a primary obstetrical diagnosis, as pregnant women were largely insured in MA prior to and following reform (Hyams 2010). We used median zip code income from 2000 Census data to infer patients' socioeconomic status, the latest year for which zip code-level estimates are available prior to the study baseline period (2004–2006) (Fiscella and Franks 2001).

Definition of Pre- and Postreform Periods

We examined hospital discharges for 36 months (1/1/2008 to 12/30/2010) following the MA mandate for health reform ("postreform" period) and contrasted it with the 21 months (10/1/2004 to 6/30/2006) preceding reform ("prereform" period); we also examined changes during the transition period (7/1/2006 to 12/31/2007), when elements of the reform were phased in gradually.

Measures

Our primary outcome was the change in the rate of substance use disorder-related hospitalizations (number of hospitalizations per 100,000 population) from the pre- to postreform period adjusted for secular changes unrelated to health reform (separately for drug- and alcohol-related discharges). The denominator of this outcome was the county population size within the age group of interest (18–64). In the difference-in-differences analysis, we measured the reform-associated change in hospitalization rate in the 18–64 age group residing in high-uninsurance counties (prereform), treating the same-age group adults residing in low-uninsurance counties as controls. We

dichotomized MA's 14 counties into two groups of seven counties based on their 2005 uninsurance rate (>11.7 percent uninsured vs. ≤ 11.7 percent uninsured).

We employed AHRQ's Clinical Classifications Software (CCS), which uses ICD-9-CM diagnosis codes, to identify substance use disorder-related diagnoses (Table S1) (Heslin KC). The primary diagnosis is that condition identified to be chiefly responsible for the patient's hospital admission. Secondary diagnoses are concomitant conditions that coexist at the time of admission or develop during the hospitalization.

Analysis

We aggregated counts of substance use disorder-related hospitalizations by area (county), time (quarter) and patient demographics (sex, age). With 14 counties, 25 quarters, three age groups, and two sex categories, our analytic data consisted of 2,100 observations. Using the census population for each cohort, we obtained the rate of substance use disorder-related hospitalizations per 1,000 population, the primary outcome measure for our analysis. In accordance with the difference-in-differences specification, we estimate a linear regression including dichotomous indicators (1/0) of the postreform period, high baseline uninsurance county, and the interaction of these two indicators. In this model, the coefficient of the interaction term was interpreted as the reform-associated change in substance use disorder-related hospitalizations. Our model specification allowed for differential prereform levels and longitudinal trends in substance use-related hospitalization rates between high-versus low-uninsurance counties (Ryan, Burgess, and Dimick 2015); see Table 2a for the full model specification. For ease of interpretation, we expressed these changes as a percentage of the baseline hospitalization rate. Standard errors were adjusted for clustering of observations at the county level. As a sensitivity analysis, we estimated an alternative model specification obtained from the interrupted time series framework (Wagner et al. 2002; Garabedian et al. 2017); see Table S3 for details. To evaluate the appropriateness of the difference-in-differences specification, we tested the assumption of parallel trends to ensure that the prereform trends in the target and control groups were similar (Ryan, Burgess, and Dimick 2015; Garabedian et al. 2017).

We also analyzed the sensitivity of our findings to utilizing only the principal discharge diagnosis (and not secondary discharge diagnoses), and we performed all of the above-mentioned analyses based on this subgroup of discharges. These sensitivity findings are reported in Tables S4–6 and Figure S1.

The Boston University Medical Campus IRB approved this study. We did not suppress any results due to small cell size. All statistical analysis was performed using the *STATA* statistical package, Version 14.

RESULTS

Table 1 shows the demographic characteristics of the entire study population (373,751 MA discharges with a primary or secondary substance use disorder–related diagnosis), as well as characteristics of the populations being compared (adult discharges age 18–64 residing in counties with high versus low rates of uninsurance during the prereform period). Slightly over half of all discharges were alcohol use disorder–related; most drug use disorder–related discharges were opioid related.

Population-based rates of substance use disorder–related hospital discharges increased in all groups after MA health reform (Table 2; Figure 1). Prereform, the number of drug use–related and alcohol use–related discharges per 1,000 population were 7.21 and 8.87, respectively, in high–(baseline) uninsurance counties, and 8.58 and 9.63 in low-uninsurance counties. In high uninsurance counties, drug use disorder–related discharges rose by 3.0 percent, and alcohol use disorder–related discharges rose by 3.8 percent. In low-uninsurance counties, drug use disorder–related discharges rose by 9.9 percent, and alcohol use disorder–related discharges rose by 2.8 percent.

After adjusting for prereform differences in discharge rates, both in levels and trends, between high- and low-uninsurance counties, MA health reform was associated with a nonsignificant reduction in drug use–related discharge rate by 0.75 (95 percent CI -1.78 to 0.27), amounting to 10.5 percent reduction, and a nonsignificant increase in alcohol use–related discharge rate by 0.06 (95 percent CI -0.98 to 1.1), amounting to 0.7 percent increase (Table 2). The tests of parallel trends indicated that difference-in-differences specifications were appropriate for both cohorts; that is, prior to reform, the longitudinal change in drug and alcohol use disorder–related hospitalizations was similar between the two groups (Table S2).

Alternate model specification using an interrupted time series framework also indicated no significant change in drug use–related and alcohol use–related discharge rates associated with reform (Table S3). For alcohol use–related discharge rates, our findings did not change when we limited the analysis to discharges identified using the principal discharge diagnosis.

Table 1: Characteristics of Substance Use–Related Discharges[†] in Massachusetts Age 18–64, 2004–2010

	<i>Total Population</i>	<i>Massachusetts Counties with High Rates of Uninsurance Prereform (Most Affected by Reform)[‡]</i>	<i>Massachusetts Counties with Low Rates of Uninsurance Prereform</i>
Number of discharges 2004–2010	373,751	181,891	191,860
Characteristics			
Age (year), mean (SD)	42.6 (12.05)	43.2 (12.00)	42.1 (12.06)
Female sex, No. (%)	125,042 (33.46)	60,892 (33.48)	64,150 (33.44)
Race, No. (%)			
Non-Hispanic black	35,067 (9.38)	21,815 (11.99)	13,252 (6.91)
Hispanic	32,695 (8.75)	14,155 (7.78)	18,540 (9.66)
Other	21,388 (5.72)	11,491 (6.32)	9897 (5.16)
Non-Hispanic white	284,601 (76.15)	134,430 (73.91)	150,171 (78.27)
Income, No. (%)			
<\$50,000 [§]	240,600 (64.37)	112,421 (61.81)	128,179 (66.81)
Top 5 primary discharge diagnoses, No. (%) [¶]			
1. Alcohol withdrawal	21,245 (5.68)	10,876 (5.98)	10,369 (5.4)
2. Opioid dependence–continuous	15,111 (4.04)	6051 (3.33)	9060 (4.72)
3. Acute pancreatitis	11,192 (2.99)	5685 (3.13)	5507 (2.87)
4. Drug withdrawal	10,524 (2.82)	6220 (3.42)	4304 (2.24)
5. Opioid dependence unspecified	9597 (2.57)	1408 (0.77)	8189 (4.27)
Category of discharge diagnoses where substance use is primary or secondary diagnosis, No. (%)			
1. Alcohol related	199,483 (53.37)	100,468 (55.24)	99,015 (51.61)
2. Drug-related, substance not specified	42,289 (11.31)	20,888 (11.48)	21,401 (11.15)
3. Opioid related	57,767 (15.46)	27,214 (14.96)	30,553 (15.92)
4. Stimulant (cocaine and amphetamines) related	32,856 (8.79)	15,661 (8.61)	17,195 (8.96)
5. Cannabis related	31,486 (8.42)	13,431 (7.38)	18,055 (9.41)
6. Other drug related	9870 (2.64)	4229 (2.33)	5641 (2.94)

[†]Hospitalizations with a substance use disorder–related diagnosis (alcohol or other drug) as a primary or secondary discharge diagnosis. All-payer inpatient discharge data from MA, includes all non-federal short-term acute care hospitals; inpatient psychiatric and detoxification facilities are excluded.

[‡]Counties are dichotomized based on their uninsurance rates among nonelderly adults in 2005.

[§]Based on zip code median household income.

[¶]Discharge diagnoses categorized by AHRQ’s Clinical Classifications Software (CCS).

However, for drug use–related discharge rates, the findings varied across the two models estimated (Tables S4–6). Specifically, MA health reform was associated with a statistically significant reduction in drug use–related discharges

Table 2: Change in Substance Use–Related Discharge[†] Rates Associated with MA Health Reform[‡] (a) Full Model Estimates of Incidence Rate Ratios[§]; (b) Difference-in-Differences Estimates of Percent Change in Rates of Drug and Alcohol-Related Hospitalizations Associated with Reform

(a)	Drug Use–Related Discharge Rate	Alcohol Use–Related Discharge Rate
Postreform period	1.67 (1.06, 2.28)	0.92 (0.34, 1.5)
High uninsurance rate counties	–0.25 (–0.97, 0.47)	–0.99 (–1.85, –0.13)
Postreform*high uninsurance rate counties	–0.75 (–1.78, 0.27)	0.06 (–0.98, 1.1)
Female	–4.06 (–5.61, –2.52)	–8.52 (–10.51, –6.53)
Age group (ref = 18–44)		
45–54	3.73 (0.22, 7.23)	14.23 (9.45, 19.02)
55–64	–3.78 (–6.2, –1.36)	5.79 (3.03, 8.56)
Transition	Omitted due to collinearity	Omitted due to collinearity
Transition*high uninsurance rate counties	–0.25 (–0.89, 0.4)	0.03 (–0.77, 0.83)
Indicators of quarter ($n = 25$)	Included	Included
Indicators of county ($n = 14$)	Included	Included
Interaction between prereform quarter and high uninsurance county	Included	Included
Constant (intercept)	7.76 (6.9, 8.63)	8.24 (7.5, 8.98)

Continued

Table 2. Continued

(b)	Age- and Sex-Standardized Discharge Rate (/1,000 Population)				Difference in Difference MA High- vs. Low-Uninsurance Counties Associated with Health Reform**			
	95% Confidence Interval		95% Confidence Interval		Overall Change (%) Pre- to Postreform, Unadjusted†	Mean	p-Value	95% Confidence Interval
	Prereform	Postreform	Prereform	Postreform				
Drug use-related discharges								
MA high-uninsurance counties	7.21	7.14	7.27	7.42	7.36	7.49		
MA low-uninsurance counties	8.58	8.51	8.66	9.44	9.36	9.51		
Alcohol use-related discharges								
MA high-uninsurance counties	8.87	8.80	8.94	9.20	9.13	9.27		
MA low-uninsurance counties	9.63	9.55	9.70	9.90	9.82	9.98		

†Hospitalizations with a drug or alcohol use disorder-related diagnosis as a primary or secondary discharge diagnosis.
‡All-payer inpatient discharge data from MA, includes all non-federal short-term acute care hospitals; inpatient psychiatric and detoxification facilities are excluded. Prereform period defined as the 39 months (10/1/2004 to 12/31/2007) preceding the MA mandate for health reform; post reform period defined as the 36 months (1/1/2008 to 12/30/2010) following MA reform. Transition period (7/1/2006 to 12/31/2007) included.
§We estimated the following linear regression model.
Drug or alcohol-use rate = Intercept + (β_1 * postreform) + (β_2 * highunins) + (β_3 * postreform * highunins) + (β_4 * transition) + (β_5 * transition * highunins) + (β_6 * female) + (β_7 * age indicators) + (β_8 * Quarter indicators) + (β_9 * Prereform quarter indicator * highunins) + (β_{10} * County indicators)

¶Overall change is the % change between prereform and postreform discharge rates.
**Change in discharge rate associated with MA health reform is given by β_3 estimate. Using prereform rate as the baseline, the change is expressed in % terms.

Figure 1: Observed Longitudinal Rates of Drug and Alcohol Use-Related Discharges per 1,000 Population in Massachusetts, 2005–2010 [Color figure can be viewed at wileyonlinelibrary.com]

using difference-in-differences estimates (Table S5b), but not in the interrupted time series model (Table S6b).

DISCUSSION

Substance use disorder–related hospitalizations increased from 2004 to 2010 in MA. We did not observe a differential change in rates of substance use disorder–related hospital discharges in comparisons according to county level of uninsurance prior to reform. We suspect this is the case because individuals could have moved across counties to obtain needed services, given the small number of hospitals in the state and their concentration in urban areas (e.g., in Boston, Worcester, and Springfield, MA, USA). In addition, most addiction treatment is supported by direct public funding and not insurance (Stewart and Horgan 2011). Thus, access to treatment may depend more on availability than insurance. Finally, persons with addiction may be prompted to enter addiction treatment in the setting of a crisis, such as a hospitalization. Expanding health insurance alone may not alter this path to addiction treatment.

Even though access to drug treatment improved over the study period, we did not observe a significant decrease in drug use–related hospitalizations. According to state-level data from the National Survey of Substance Abuse Treatment Services (N-SSATS) (SAMSHA 2006) in MA, the number of clients in drug use disorder treatment rose over the study period, from 246 per 100,000 population in 2005 to 278 per 100,000 population in 2009. In contrast, the number of clients in alcohol use disorder treatment over the same period was virtually unchanged, from 104 per 100,000 population in 2005 to 105 per 100,000 population in 2009 (SAMSHA 2006). Individuals with health insurance yet no access to alcohol use disorder treatment could be at risk for alcohol use disorder–related hospitalizations. Similarly, in theory, those receiving drug use disorder treatment could avert an inpatient hospitalization related to drug use disorders. For patients with drug use disorders, addiction treatment has been associated with lower rehospitalization rates (Laine et al. 2001) and emergency department use (Laine et al. 2005). However, we did not observe this.

Our findings for changes in substance use disorder–related hospitalizations following MA health reform contradict one prior study in this area. The Meara study of adults age 19–25 found relative reductions in all substance use disorder–related medical hospitalizations in MA compared to other states

(Meara et al. 2014). It is possible that our findings differed from Meara et al. (2014) because we examined a broader age group, those age 18–64. The Capoccia study did not find increased access to substance use disorder treatment in the immediate 24 months after MA health reform (Capoccia et al. 2012), which is consistent with our findings. In our study, we looked at 18 months after MA health reform, a period when access to drug use disorder treatment may have been expanded. Further studies that include medical, psychiatric, and addiction hospitalizations, a longer time window, and more detailed data about other contributing factors are needed to demonstrate the mechanisms by which health insurance expansion affects substance use disorder–related hospitalizations.

One possible explanation for the increase in substance use disorder–related hospitalizations across all groups we studied is reduced access to inpatient mental health care. During the postreform period (Oct 2008–Sept 2012), the MA mental health budget was cut by 8.1 percent (Honberg et al. 2011). And, over the study period, the state of MA experienced a 31 percent reduction in the number of public psychiatric hospital beds (Treatment Advocacy Center 2013). We speculate that many individuals with mental illness and comorbid substance use disorders, but now without access to inpatient psychiatric care, may have been admitted to medical hospitals due to medical manifestations of untreated psychiatric symptoms that would have otherwise been addressed through inpatient psychiatric care.

Our study adds to—and expands—the prior literature in several ways. We examine changes from the pre- to postreform period in numbers of medical and surgical hospitalizations in MA where substance use disorder–related conditions are the primary *or* secondary diagnosis (e.g., a hospitalization for pneumonia where a substance use disorder is a secondary diagnosis), whereas prior studies (Meara et al. 2014) have only included primary substance use disorder diagnoses. In our dataset, approximately one-fifth of substance use disorder–related discharges had a substance use disorder–related diagnosis as the primary diagnosis. By including all discharges with a primary or secondary diagnosis of a substance use–related condition, we are examining the universe of discharges that may have been affected by substance use disorders. It is possible that observed changes in the rate of discharges with a secondary substance use disorder–related diagnosis could be driven by changes in access to care for the primary, medical diagnosis. However, our prior work suggests that MA health reform had little effect on reducing admissions for a number of medical conditions (Lasser et al. 2014; McCormick et al. 2015). Further, in sensitivity analyses

limited to hospitalizations with substance use as a primary diagnosis, with one exception (drug use–related discharges using difference-in-differences estimates), our findings did not change.

Our analyses utilize more recent data than prior studies, through 2010. Our study has several limitations. We did not have data on mediating variables along the causal chain between availability of insurance and hospitalizations with substance use disorder–related diagnoses. Such mediating variables include utilization of outpatient or inpatient addiction treatment. Thus, we cannot determine whether a lack of access to care prevented substance use disorder–related hospitalizations from declining in MA. We also lacked data on other mediating variables such as whether primary care providers in some communities accepted the newer forms of health insurance in MA. We cannot separate the effects from the two different changes (substance use treatment funding increases and insurance coverage expansion) that took place during the study period. In addition, our findings may not be generalizable to other states that have implemented insurance expansions. Knudsen (2015) has shown that there are large regional differences in access to substance use disorder treatment, particularly in the supply of physicians waived (e.g., permitted) to prescribe buprenorphine for the treatment of opioid use disorders. MA, with 18 buprenorphine-waivered physicians per 100,000 residents in 2013, has a much greater supply of waived physicians than other states. Physicians with training to prescribe and administer Schedule III, IV, or V drugs for the treatment of addiction or detoxification must obtain a waiver from the Substance Abuse and Mental Health Services Administration (SAMSHA) to prescribe buprenorphine. Although these data do not correspond to the study period of our paper, they suggest that it is possible that a state could expand insurance coverage, yet have inadequate physician supply to treat newly insured individuals with substance use disorders. This, in turn, could result in persistently high rates of substance use disorder–related hospitalizations.

Conclusions and Policy Implications

We have shown that in a state with a low baseline uninsurance rate, a health insurance expansion was associated with no significant changes in hospitalizations related to substance use disorders in county-based comparisons. Further research is needed to determine how to reduce substance use disorder–related hospitalizations, beyond expanding insurance coverage.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: The authors acknowledge the support of their home institutions for providing working space and infrastructure to facilitate the completion of this work, including Boston University School of Medicine, Boston Medical Center, Boston University School of Public Health, and Harvard Medical School. This research has been supported by the NIH (1U01HL105342, N. Kressin, PI). Dr. Kressin is supported in part by a Research Career Scientist award from the Department of Veterans Affairs, Health Services Research & Development Service (RCS 02-066-1). Dr. Karen Lasser had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. The Boston University Medical Campus institutional review board reviewed this study.

The views expressed in this article are those of the authors and do not necessarily represent the views of the National Institutes of Health, Boston University, Boston Medical Center, Harvard Medical School, or the Department of Veterans Affairs.

We acknowledge The Massachusetts Center for Health Information and Analysis. All analyses are our own, and this agency bears no responsibility or liability for the results. We thank Maxim D. Shrayar, Ph.D. who commented on earlier drafts of the manuscript, and Lisa Marks, B.S., for assisting with manuscript preparation. They received no compensation for their contributions, and written permissions to use their contributions have been obtained.

Disclosures: None.

Disclaimer: None.

REFERENCES

- Bindman, A. B., K. Grumbach, D. Osmond, M. Komaromy, K. Vranizan, N. Lurie, J. Billings, and A. Stewart. 1995. "Preventable Hospitalizations and Access to Health Care." *JAMA* 274 (4): 305–11.
- Boston: Division of Health Care Finance and Policy. 2009. "FY2007 Inpatient Hospital Discharge Database Documentation Manual. Massachusetts Executive Office of Health and Human Services MA Division of Health Care Finance and Policy" [accessed on February 6, 2017]. Available at <http://archives.lib.state.ma.us/bitstream/handle/2452/207102/ocn858920239-FY2007.pdf?sequence=1>
- Capoccia, V. A., K. L. Grazier, C. Toal, J. H. Ford 2nd, and D. H. Gustafson. 2012. "Massachusetts's Experience Suggests Coverage Alone Is Insufficient to Increase Addiction Disorders Treatment." *Health Affairs* 31 (5): 1000–8.

- Dimick, J. B., and A. M. Ryan. 2014. "Methods for Evaluating Changes in Health Care Policy: The Difference-in-Differences Approach." *JAMA* 312 (22): 2401–2.
- Fiscella, K., and P. Franks. 2001. "Impact of Patient Socioeconomic Status on Physician Profiles: A Comparison of Census-Derived and Individual Measures." *Medical Care* 39 (1): 8–14.
- Garabedian, L. F., D. Ross-Degnan, S. B. Soumerai, N. K. Choudhry, and J. S. Brown. 2017. "Impact of Massachusetts Health Reform on Enrollment Length and Health Care Utilization in the Unsubsidized Individual Market." *Health Services Research* 52 (3): 1118–37. <https://doi.org/10.1111/1475-6773.12532>
- Gelberg, L., R. M. Andersen, and B. D. Leake. 2000. "The Behavioral Model for Vulnerable Populations: Application to Medical Care Use and Outcomes for Homeless People." *Health Services Research* 34 (6): 1273–302.
- Hanchate, A. D., K. E. Lasser, A. Kapoor, J. Rosen, D. McCormick, M. M. D'Amore, and N. R. Kressin. 2012. "Massachusetts Reform and Disparities in Inpatient Care Utilization." *Medical Care* 50 (7): 569–77.
- Hanchate, A. D., A. Kapoor, J. N. Katz, D. McCormick, K. E. Lasser, C. Feng, M. G. Manze, and N. R. Kressin. 2015. "Massachusetts Health Reform and Disparities in Joint Replacement Use: Difference in Differences Study." *BMJ* 350: h440.
- Heslin, K. C., and E. A. Steiner. 2015. "Statistical Brief #191; Hospitalizations Involving Mental and Substance Use Disorders among Adults, 2012." Healthcare Cost and Utilization Project (HCUP). June 2015 ed: Agency for Healthcare Research and Quality, Rockville, MD [accessed on April 26, 2017]. Available at <https://www.hcup-us.ahrq.gov/reports/statbriefs/sb191-Hospitalization-Mental-Substance-Use-Disorders-2012.pdf>
- Honberg, R., A. Kimball, S. Diehl, L. Usher, and M. Fitzpatrick. 2011. "State Mental Health Cuts: The Continuing Crisis. A Report by the National Alliance on Mental Illness" [accessed on April 24, 2017]. Available at namimass.org/wp-content/uploads/State-Mental-Health-Cuts-The-Continuing-Crisis.pdf
- Hyams, T. C. L. 2010. "Massachusetts Health Reform: Impact on Women's Health" [accessed on May 2, 2013]. Available at http://masshealthpolicyforum.brandeis.edu/forums/Documents/Issue%20Brief_ConnorCenter.pdf
- Joynt, K. E., D. M. Blumenthal, E. J. Orav, F. S. Resnic, and A. K. Jha. 2012. "Association of Public Reporting for Percutaneous Coronary Intervention with Utilization and Outcomes Among Medicare Beneficiaries with Acute Myocardial Infarction." *JAMA* 308 (14): 1460–8.
- Knudsen, H. K. 2015. "The Supply of Physicians Waivered to Prescribe Buprenorphine for Opioid Use Disorders in the United States: A State-Level Analysis." *Journal of Studies on Alcohol and Drugs* 76 (4): 644–54.
- Laine, C., W. W. Hauck, M. N. Gourevitch, J. Rothman, A. Cohen, and B. J. Turner. 2001. "Regular Outpatient Medical and Drug Abuse Care and Subsequent Hospitalization of Persons Who Use Illicit Drugs." *JAMA* 285 (18): 2355–62.
- Laine, C., Y. T. Lin, W. W. Hauck, and B. J. Turner. 2005. "Availability of Medical Care Services in Drug Treatment Clinics Associated with Lower Repeated Emergency Department Use." *Medical Care* 43 (10): 985–95.

- Lasser, K. E., A. D. Hanchate, D. McCormick, M. G. Manze, C. Chu, and N. R. Kressin. 2014. "The Effect of Massachusetts Health Reform on 30 Day Hospital Readmissions: Retrospective Analysis of Hospital Episode Statistics." *BMJ* 348: g2329.
- Mack, K. 2013. "Drug-Induced Deaths — United States, 1999–2010" [accessed on June 29, 2015]. Available at <http://www.cdc.gov/mmwr/pdf/other/su6203.pdf>
- McCormick, D., A. D. Hanchate, K. E. Lasser, M. G. Manze, M. Lin, C. Chu, and N. R. Kressin. 2015. "Effect of Massachusetts Healthcare Reform on Racial and Ethnic Disparities in Admissions to Hospital for Ambulatory Care Sensitive Conditions: Retrospective Analysis of Hospital Episode Statistics." *BMJ* 350: h1480.
- Meara, E., E. Golberstein, R. Zaha, S. F. Greenfield, W. R. Beardslee, and S. H. Busch. 2014. "Use of Hospital-Based Services among Young Adults with Behavioral Health Diagnoses before and after Health Insurance Expansions." *JAMA Psychiatry* 71 (4): 404–11.
- NASADAD. 2010. "Effects of State Health Care Reform on Substance Abuse Services in Maine, Massachusetts, and Vermont" [accessed on February 6, 2017]. Available at <http://www.asaptexas.org/pdfs/NASADADReport.pdf>
- O'Connor, P. G., R. J. Sokol, and G. D'Onofrio. 2014. "Addiction Medicine: The Birth of a New Discipline." *JAMA Internal Medicine* 174 (11): 1717–8.
- Ryan, A. M., J. F. Burgess Jr, and J. B. Dimick. 2015. "Why We Should Not Be Indifferent to Specification Choices for Difference-in-Differences." *Health Services Research* 50 (4): 1211–35.
- SAMSHA. 2006. "National Survey of Substance Abuse Treatment Services (N-SSATS): 2005 Data on Substance Abuse Treatment Facilities" [accessed on March 24, 2015]. Available at <http://www.samhsa.gov/>
- SAMHSA. 2010. "Substance Abuse and Mental Health Services Administration OoAS. Results from the 2009 National Survey on Drug Use and Health: Mental Health Findings. NSDUH Series H-39" [accessed on June 29, 2015]. Available at <https://www.counseling.org/docs/public-policy-resources-reports/2k9mentalhealthresults.pdf?sfvrsn=2>
- Simpson, D. D. 2004. "A Conceptual Framework for Drug Treatment Process and Outcomes." *Journal of Substance Abuse Treatment* 27 (2): 99–121.
- Sommers, B. D., K. Baicker, and A. M. Epstein. 2012. "Mortality and Access to Care Among Adults after State Medicaid Expansions." *New England Journal of Medicine* 367 (11): 1025–34.
- Stewart, M. T., and C. M. Horgan. 2011. "Health Services and Financing of Treatment." *Alcohol Research and Health* 33 (4): 389–94.
- Stryjewski, T. P., F. Zhang, D. Elliott, and J. F. Wharam. 2014. "Effect of Massachusetts Health Reform on Chronic Disease Outcomes." *Health Services Research* 49 (Suppl. 2): 2086–103.
- Substance Abuse and Mental Health Services Administration, Office of Applied Studies. 2010. "Results from the 2009 National Survey on Drug Use and Health: Mental Health Findings" [accessed on June 29, 2010]. Available at <https://www.counseling.org/docs/public-policy-resources-reports/2k9mentalhealthresults.pdf?sfvrsn=2>

- Treatment Advocacy Center. 2013. "Massachusetts: An Assessment on the Commonwealth's Access to Treatment for Persons with Severe Mental Illness" [accessed on December 7, 2015]. Available at <http://www.treatmentadvocacycenter.org/storage/documents/2013-massachusetts-assessment.pdf>
- Wagner, A. K., S. B. Soumerai, F. Zhang, and D. Ross-Degnan. 2002. "Segmented Regression Analysis of Interrupted Time Series Studies in Medication Use Research." *Journal of Clinical Pharmacy and Therapeutics* 27 (4): 299–309.
- WHO. 2003. "Department of Mental Health and Substance Dependence, Health NDaM, Investing in Mental Health." [Electronic Report]. [accessed on June 29, 2015]. Available at <http://whqlibdoc.who.int/publications/2003/9241562579.pdf>

SUPPORTING INFORMATION

Additional supporting information may be found online in the supporting information tab for this article:

Appendix SA1: Author Matrix.

Figure S1: Observed Longitudinal Rates of Drug and Alcohol Use-Related Discharges per 1,000 Population in Massachusetts, 2005–2010 (discharges identified by primary diagnosis).

Table S1: Substance Use Disorder–Related ICD-9 Codes.

Table S2: Test of Validity of Comparison Cohort.

Table S3: Change in Substance Use–Related Discharge Rates Associated with MA Health Reform: Interrupted Time Series Models.

Tables S4: Characteristics of Substance Use–Related Discharges in Massachusetts age 18–64, 2004–2010 [discharges identified by primary diagnosis].

Table S5: Change in Substance Use–Related Discharge Rates Associated with MA Health Reform [discharges identified by principal diagnosis code].

Table S6: Change in Substance Use–Related Discharge Rates Associated with MA Health Reform: Interrupted Time Series Models [discharges identified by principal diagnosis code] .