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By Ashley C. Bradford and W. David Bradford

# Medical Marijuana Laws May Be Associated With A Decline In The Number Of Prescriptions For Medicaid Enrollees

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**ABSTRACT** In the past twenty years, twenty-eight states and the District of Columbia have passed some form of medical marijuana law. Using quarterly data on all fee-for-service Medicaid prescriptions in the period 2007–14, we tested the association between those laws and the average number of prescriptions filled by Medicaid beneficiaries. We found that the use of prescription drugs in fee-for-service Medicaid was lower in states with medical marijuana laws than in states without such laws in five of the nine broad clinical areas we studied. If all states had had a medical marijuana law in 2014, we estimated that total savings for fee-for-service Medicaid could have been \$1.01 billion. These results are similar to those in a previous study we conducted, regarding the effects of medical marijuana laws on the number of prescriptions within the Medicare population. Together, the studies suggest that in states with such laws, Medicaid and Medicare beneficiaries will fill fewer prescriptions.

**D**espite the support for the clinical use of marijuana expressed by patient groups and many members of Congress, the Drug Enforcement Administration continues to classify marijuana as a Schedule I drug (the category with no legally permitted uses) under the Controlled Substances Act of 1970. One legislative criteria for categorizing a drug as Schedule I is that the drug have no “currently accepted medical use[s].”<sup>21</sup> While there are no administrative data that can be used to directly examine medical uses of marijuana, it is possible to examine contemporaneous patterns of marijuana and prescription drug use in states that have enacted a medical marijuana law and thus to assess whether patients are substituting medical marijuana for prescription drugs. If they are, this would be an indirect indication that medical marijuana has accepted medical uses.

There is a rapidly growing literature about the clinical effects of medical marijuana on specific

diseases and symptoms<sup>2–4</sup> and an expanding economic literature on the effects of marijuana legalization on traffic accidents,<sup>5,6</sup> illicit drug use among youth,<sup>6–8</sup> and recreational marijuana legalization policies.<sup>9</sup> However, almost nothing is known about how state medical marijuana policies affect traditional clinical care in the community or spending in the health care sector.

We recently examined whether state medical marijuana laws were associated with changes in the use of prescription drugs approved by the Food and Drug Administration (FDA) among Medicare Part D enrollees, and we found statistically and economically meaningful reductions in prescription drug use associated with the laws.<sup>10</sup> This finding suggested that patients in states with such laws were substituting medical marijuana for prescription drugs.

That research, while the first of its kind, was restricted to prescriptions written for Medicare Part D enrollees, most of whom are over age sixty-five. To understand the relationship be-

tween state medical marijuana laws and use of FDA-approved medications in a generally younger population, we investigated the association between medical marijuana laws and prescription drug spending in the period 2007–14 in the fee-for-service Medicaid programs of all fifty states and the District of Columbia. We studied this association using quarterly data at the drug-state level for a comprehensive set of prescription drugs used to treat conditions in nine clinical areas. We hypothesized that medical marijuana laws would be associated with a decrease in prescribing of FDA-approved drugs because medical marijuana would substitute for those drugs.

### Study Data And Methods

**DATA ON STATE MEDICAL MARIJUANA LAWS** We collected dates of the passage and enactment of medical marijuana laws across states from a variety of published sources.<sup>11–15</sup> These sources list when laws were passed and went into effect, and they characterize whether home cultivation or dispensaries are permitted (or required). The sources occasionally disagreed about the timing of key events (such as dispensary openings). Whenever the sources disagreed, we used the earliest date from any source. For this research we followed the authors of previous studies and designated the date of implementation of the medical marijuana law as the relevant date.<sup>14,16</sup> Dates are presented in online Appendix Exhibit 10.<sup>17</sup>

The landscape of state medical marijuana laws has changed drastically in the past twenty years. The first such law was passed in California in 1996. As of December 2016, twenty-eight states and the District of Columbia had passed laws that recognize the medicinal applications of marijuana.<sup>11</sup>

State medical marijuana laws vary greatly. In fourteen of the states that have passed such a law, patients (or their designated caregivers) are permitted to cultivate marijuana at home.<sup>11</sup> Because the process of growing a viable marijuana plant is lengthy and difficult, dispensaries have been permitted in many states as a way to provide access to medical marijuana more quickly and easily. In 2009 New Mexico became the first state to allow dispensaries, and every state medical marijuana law enacted since then has included some form of dispensary program.<sup>18</sup>

States vary substantially in the conditions that can make patients eligible for access to medical marijuana. Each state medical marijuana law requires that a patient must have an approved illness, usually defined in the law, for a physician to recommend the use of medical marijuana.<sup>19</sup> We

relied on a list of approved conditions from all states (which is provided in the Appendix),<sup>17</sup> along with summaries of clinical evidence for marijuana treatment effects (discussed below), to select the drugs to analyze in this study.

**DATA ON MEDICAID PRESCRIPTIONS FOR APPROVED DRUGS** We used State Drug Utilization Data as our source of data on FDA-approved prescription drugs. The Centers for Medicare and Medicaid Services (CMS) has collected these data quarterly since the start of the Medicaid Drug Rebate Program in 1990. The data cover all drugs reimbursed by each state's Medicaid program. Drugs are identified by their National Drug Code and product name. Data fields include the number of units of each outpatient drug dispensed and total Medicaid payments for those drugs aggregated at the state-quarter level.<sup>20</sup>

Before the introduction of Medicare Part D in 2006, people dually eligible for Medicare and Medicaid received prescription drug coverage through Medicaid, and their use of such drugs showed up in the State Drug Utilization Data. Following the introduction of Part D, Medicare began covering most prescription drugs for dual eligibles, which produced a sharp reduction in the numbers of paid prescriptions in the Medicaid expenditure data. Consequently, we analyzed State Drug Utilization Data for 2007 (to avoid noise introduced into the data from the disruption to the Medicaid program from the gradual migration of enrollees to Medicare Part D throughout 2006) through 2014, the last year for which full data were available.

To accurately determine the effect of medical marijuana laws on prescribing behavior, we restricted our analysis to prescription drugs used to treat clinical conditions for which marijuana might be a potential alternative treatment. To identify these drugs, we followed the methodology used in our earlier study of the association of medical marijuana laws and prescription drugs in the Medicare population,<sup>10</sup> as explained in detail in the Appendix.<sup>17</sup> We selected nine clinical areas to study: anxiety, depression, glaucoma, nausea, pain, psychosis, seizure disorders, sleep disorders, and spasticity.

To account for the widespread practice of off-label prescribing, we used data on all drugs that were in the same class as at least one on-label drug for the diagnoses (designated by *International Classification of Diseases*, Ninth Revision [ICD-9], codes) included in our nine clinical areas for which medical marijuana was considered a treatment. More details about the methodology we used to identify the study drugs are in the Appendix.<sup>17</sup>

**DATA FOR COVARIATES** We collected data on state-level characteristics from several sources.

Data on overall Medicaid enrollment and managed care enrollment were taken from the Henry J. Kaiser Family Foundation.<sup>21</sup> State sociodemographic data were extracted from various years of the Area Health Resources Files, maintained by the Health Resources and Services Administration.<sup>22</sup>

**MEASURES** We extracted the number of total daily doses for each study drug from the State Drug Utilization Data. We aggregated daily doses for each specific drug up to the drug-class level (as defined by the Cerner Multum drug database). Then we divided the number of doses filled by the number of Medicaid enrollees in each state as of December of the relevant year. Our primary outcome variable was the log of the average number of daily doses of an FDA-approved prescription drug dispensed per Medicaid enrollee in each state per quarter and year. We created nine such Medicaid prescribing data sets, one for each clinical area listed above. Details of this process are in the Appendix.<sup>17</sup>

Our primary explanatory variable was the presence of a state medical marijuana law for each observation. This indicator variable had a value of 1 when an observation was in a state, year, and quarter with such a law in effect and a value of 0 otherwise. As discussed above, we categorized a medical marijuana law as being in effect whenever it was legal under state law for a patient to possess medical marijuana.

As covariates, we used the following state-level characteristics: whether the state had a prescription drug monitoring program in effect; the number of active nonfederal physicians per capita; median household income; the percentage of state residents with household incomes below the federal poverty level; the average annual unemployment rate; the state population; whether the state had legalized recreational marijuana; whether the state had expanded eligibility for Medicaid under the Affordable Care Act; and state and year indicator variables, to allow for fixed effects analysis by state and year.

**STATISTICAL ANALYSIS** We first tested whether each drug class was associated with a state's medical marijuana law status using *t*-tests. As our main analyses, we estimated a series of difference-in-differences multiple regression models in which the dependent variable was the logged number of daily doses filled per enrollee. We estimated separate regressions for each of the nine clinical areas. We logged the dependent variable to account for skewness in the data on units dispensed. We used a Huber-White covariance estimator to account for heteroskedasticity and for the fact that we had repeated observations from the each state. Since our dependent variable was logged units dispensed, the estimated

coefficients represented percentage changes.

For all drugs except those used to treat glaucoma, we hypothesized that implementing a medical marijuana law would be associated with a decrease in the units dispensed for each class of drug. This hypothesis was based on the assumption that medical marijuana would generally be a substitute for existing FDA-approved prescription drugs. In the case of glaucoma, the clinical evidence suggests that marijuana affects intra-ocular pressure for only a few hours, so we expected to find no effect (for the complete set of estimated model coefficients for all models, see the Appendix).<sup>17</sup>

We report the association between having a medical marijuana law and units of prescriptions dispensed under Medicaid using 95 percent confidence intervals assuming a two-tailed test. We confirmed that trends in Medicaid prescriptions filled without the presence of a medical marijuana law were similar in states that ultimately passed such laws and states that did not, which justified our use of a difference-in-differences regression model.

Results of the full models, including all covariates and *t*-statistics and falsification tests, are presented in the Appendix.<sup>17</sup>

**COST SAVINGS ESTIMATION** In addition to analyzing the association between medical marijuana laws and changes in units filled of FDA-approved prescription drugs, we estimated reductions in total Medicaid spending associated with the implementation of a medical marijuana law. We calculated actual costs per dose using State Drug Utilization Data, and we assigned cost savings related to the law to each observation in our original drug-level data. Since prescription drugs may be used in multiple disease categories in our data (for example, some selective serotonin reuptake inhibitors could be used to treat anxiety, depression, psychosis, or sleep disorders), we eliminated any duplicates by drug, state, and quarter and kept only the observation that had the smallest estimated cost savings.

We allocated savings associated with the implementation of a medical marijuana law to each state and the federal government using the Federal Medical Assistance Percentages in effect in each year.

We also estimated counterfactual cost savings assuming that states with no medical marijuana law had one. We used State Drug Utilization Data to calculate costs per dose and assigned cost savings related to the law to each observation in our original drug-level data for states that did not actually have a law, eliminating duplicate drugs as in the main analysis.

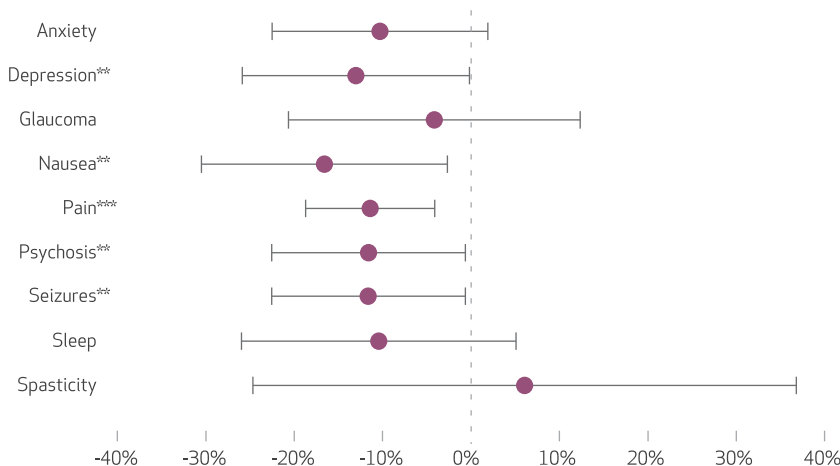
**LIMITATIONS** Our study had several limita-

tions. First, we examined only data on fee-for-service Medicaid prescribing. The treatment of pharmaceuticals under Medicaid managed care contracts is inconsistent: Only some states include pharmaceutical costs in their per member per month payments to contractors. In those cases, prescriptions to Medicaid managed care enrollees were not included in the quarterly State Drug Utilization Data. Since the treatment of prescription payments in fee-for-service Medicaid was consistent across states and years, we focused on only that component of Medicaid spending. Thus, our estimated savings for Medicaid associated with medical marijuana laws represent a lower bound, since they did not include savings in Medicaid managed care spending.

Second, state medical marijuana policy is rapidly evolving. The laws themselves are being changed, with some states adding additional approved conditions and new dispensaries opening. In three states (Arkansas, Florida, and North Dakota), voters approved a medical marijuana law in the fall 2016 election. Also in 2016, Montana removed restrictions that had prevented dispensaries from operating in the state. The spread of the laws and the increased availability of marijuana may serve to normalize its use over time. Thus, one might expect the impact of the laws on behavior to increase over time—which suggests again that our measured associations may be lower-bound estimates.

## EXHIBIT 1

### Changes associated with a state's having a medical marijuana law in numbers of Medicaid prescriptions for drugs used to treat conditions with medical marijuana indications



**SOURCE** Authors' analysis of disease-specific data from Medicaid's State Drug Utilization Data files, 2007–14. **NOTES** Medicaid prescribing is measured as the log of the number of doses each quarter divided by the number of Medicaid enrollees, aggregated by drug class, state, and quarter. Prescribed drugs are those approved by the Food and Drug Administration to treat the relevant condition. Error bars represent 95% confidence intervals. "Seizures" means seizure disorders. "Sleep" means sleep disorders. \*\* $p < 0.05$  \*\*\* $p < 0.01$

## Study Results

**CHARACTERISTICS OF MEDICAID PRESCRIPTION SAMPLES** In each of the nine clinical areas that we chose to study, observations without a medical marijuana law in effect had fewer annual prescription units dispensed, compared to observations with a law. However, state quarters with medical marijuana laws in effect were otherwise similar to state quarters without such a law (Appendix Exhibit 3).<sup>17</sup>

**BIVARIATE RESULTS** In simple bivariate comparisons (presented in Appendix Exhibit 4),<sup>17</sup> we found that with a medical marijuana law there were fewer doses of each drug dispensed per enrollee in state fee-for-service Medicaid programs. The differences ranged from around a 42 percent reduction for prescriptions used to treat nausea (1.18 daily doses per enrollee in a state without a law versus 0.69 daily dose per enrollee in a state with a law) to a 15 percent reduction for spasticity (0.99 daily dose per enrollee in a state without a law versus 0.84 daily dose per enrollee in a state with a law).

Such bivariate comparisons leave out the impact of other confounding influences. Consequently, we estimated the multivariate models discussed above to measure the association between enactment of a medical marijuana law and fee-for-service Medicaid prescribing more accurately.

**MULTIVARIATE RESULTS** In five of the nine clinical areas that we studied, we found significant negative associations between the presence of a medical marijuana law and quarterly logged average prescription units filled for each category (Exhibit 1 and Appendix Exhibit 6).<sup>17</sup> We found that having such a law was associated with the following reductions in the average number of doses aggregated to the state, quarter, and drug-class level for FDA-approved drugs: a 13 percent reduction for drugs used to treat depression, a 17 percent reduction for those used to treat nausea, 12 percent reductions for those used to treat psychosis and those used to treat seizure disorders, and an 11 percent reduction for drugs used to treat pain. We found no significant associations between having a medical marijuana law and dispensed units of FDA-approved drugs for anxiety, glaucoma, sleep disorders, or spasticity.

To rule out effects from unobserved characteristics of states on our results, we performed falsification tests with drugs from four classes in which there is no evidence of any beneficial (or harmful) effect from medical marijuana. These drug classes were blood-thinning agents, phosphorous-stimulating agents for patients with end-stage renal disease, antivirals used to treat influenza, and antibiotics. We found no consistent evidence of an association between having a

medical marijuana law and the number of units dispensed to enrollees in fee-for-service Medicaid for three of the four drug classes. For the fourth, phosphorus stimulants, bivariate results showed an increase and multivariate results suggested a decrease. Falsification test results are shown in Appendix Exhibit 7.<sup>17</sup>

**ESTIMATING COST SAVINGS** One remaining question is how to understand the importance of these associations. To put our findings in perspective, we estimated total spending reductions for Medicaid resulting from states' having medical marijuana laws for each year of our study period (Exhibit 2). Total estimated Medicaid savings associated with these laws ranged from \$260.8 million in 2007 to \$475.8 million in 2014. Given that total spending observed in the fee-for-service Medicaid State Drug Utilization Data for 2014 was just under \$23.9 billion, the observed savings related to the laws were equivalent to about 2 percent of the total spending. If all states had had a medical marijuana law in place in 2014, the national savings for fee-for-service Medicaid would have been approximately \$1.01 billion. That is the average state savings in 2014 of \$19.825 million for the twenty-three states (and the District of Columbia) that had approved medical marijuana laws by that year, extrapolated to all fifty states and the District of Columbia.

Exhibit 3 shows estimated savings in 2014 for each state that had a medical marijuana law in effect, as well as federal savings for those states. Some states, such as Hawaii, with many Medicaid beneficiaries enrolled in managed care had small savings for fee-for-service Medicaid. Appendix Exhibit 9 presents estimated savings for states without a medical marijuana law under the counterfactual assumption that each state had enacted such a law.<sup>17</sup>

Given that 26 percent of Medicaid beneficiaries were enrolled in fee-for-service Medicaid in 2014, if we assume that our measured associations apply equally to Medicaid managed care (and that prescription drug use is similar in that setting), then the estimated counterfactual reduction in spending for 2014 if all states had medical marijuana laws would approach \$3.89 billion nationally. Of course, much of that amount would accrue to the private insurers that run the Medicaid managed care plans, not to state governments. Presumably, however, state governments could reduce their payments to these contractors as prescription drug costs fell.

Since among the nine areas we studied, evidence of a clinical benefit from marijuana treatment for the mental health conditions (anxiety, depression, and psychosis) and sleep disorders is weakest, we also estimated cost savings from

medical marijuana laws excluding those four areas. Those estimates (presented in Appendix Exhibit 8)<sup>17</sup> were very similar to the estimates for the full set of conditions.

## Discussion

Our findings on Medicaid prescribing behavior and estimated savings associated with medical marijuana laws, along with our previous results for Medicare enrollees,<sup>10</sup> suggest that patients and physicians in the community are reacting to the availability of medical marijuana as if it were medicine.

In August 2016 the Drug Enforcement Administration announced that it would retain marijuana's Schedule I status. This decision was made despite the substantial and growing evidence that the requirements for Schedule I status involving "no currently accepted medical uses" are no longer met by marijuana. The Drug Enforcement Administration continues to assert that for marijuana's status to be changed, cannabis must be shown to cause no harm and that its clinical benefit be proved to the level that would be needed for it to acquire new drug approval as part of an FDA-based clinical trial.

One legislative criterion for Schedule II status is that a drug have "currently accepted medical use." Meeting this criterion does not require that the drug's benefit be proved with the confidence that would satisfy the FDA when considering whether to grant new drug approval.

### EXHIBIT 2

**Estimated annual savings associated with states' having a medical marijuana law in Medicaid prescription drug spending on drugs used to treat conditions with medical marijuana indications**

	Estimated savings (millions of nominal dollars)		
	States' share	Federal share	Total
2007	125.7	135.2	260.8
2008	138.8	150.5	289.3
2009	106.4	190.4	296.8
2010	119.4	215.6	335.0
2011	170.7	198.9	369.6
2012	147.7	172.1	319.8
2013	161.7	185.3	346.9
2014	223.4	252.4	475.8
2007-14	1,193.7	1,500.4	2,694.1

**SOURCE** Authors' analysis of data from Medicaid's State Drug Utilization Data files, 2007-14. **NOTES** Estimated savings are reductions in spending on prescription drugs approved by the Food and Drug Administration to treat conditions for which medical marijuana may serve as a substitute in nine clinical areas: anxiety, depression, glaucoma, nausea, pain, psychosis, seizure disorders, sleep disorders, and spasticity. Savings are only for prescriptions dispensed as part of fee-for-service Medicaid, not for those dispensed through Medicaid managed care contracts. Thus, the estimates represent a lower bound on savings for Medicaid.

## EXHIBIT 3

**Estimated federal and individual states' 2014 savings associated with having a medical marijuana law in Medicaid prescription drug spending on drugs used to treat conditions with medical marijuana indications**

State	Estimated savings (\$)	
	State's share	Federal share
AK	1,944,311	1,944,311
AZ	72,101	147,921
CA	98,007,503	98,007,503
CO	14,429,495	14,429,495
CT	20,713,760	20,713,760
DE	4,303,530	5,326,208
DC	1,213,247	2,830,910
HI	3,913	4,214
IL	16,748,519	16,748,519
ME	3,432,821	5,495,192
MD	6,125,628	6,125,628
MA	10,666,546	10,666,546
MI	15,964,564	31,436,160
MN	4,696,356	4,696,356
MT	1,672,696	3,295,216
NV	3,770,236	6,447,206
NH	350,141	350,141
NJ	899,421	899,421
NM	118,849	267,024
NY	7,681,603	7,681,603
OR	5,033,148	8,621,622
RI	132,468	133,052
VT	3,105,997	3,813,132
WA	2,327,151	2,327,151

**SOURCE** Authors' analysis of 2014 data from Medicaid's State Drug Utilization Data files. **NOTES** Estimated savings are reductions in spending on prescription drugs approved by the Food and Drug Administration to treat conditions for which medical marijuana may serve as a substitute in the nine clinical areas listed in the Notes to Exhibit 2. Savings are only for prescriptions dispensed as part of fee-for-service Medicaid, not for those dispensed through Medicaid managed care contracts. Thus, the estimates represent a lower bound on savings. States not listed had no medical marijuana law in effect.

Our work adds to the literature that shows the potential clinical benefits of marijuana.<sup>4</sup> The American Academy of Neurology relied on the strength of the literature when it issued a committee consensus statement that cannabis "is effective" or "is probably effective" in treating important medical conditions.<sup>23</sup> Similarly, a major report issued by the National Academies of Sciences, Engineering, and Medicine in Janu-

ary 2017 found conclusive evidence that cannabis is an effective treatment for some conditions.<sup>24</sup>

The common state requirement that physicians certify that patients are eligible for medical marijuana use provides significant prima facie evidence that there is currently accepted medical use. Our findings that actual prescription drug use in Medicaid varies in ways consistent with marijuana's being a substitute product provides additional, albeit indirect, evidence of medical use, similar to recently published evidence of a response in Medicare prescribing.<sup>10</sup>

The reduced spending in Medicaid that we estimated does not represent a pure change in social welfare (as economists would define it), since some of the estimated savings represented a transfer of costs from the program to its enrollees who chose to pay for marijuana out of pocket. But in times of significant budget pressure, the possible savings of \$1.01 billion nationally in spending on prescriptions in fee-for-service Medicaid is significant.

Of course, if the Drug Enforcement Administration reclassified marijuana as a Schedule II drug and state Medicaid programs covered medical marijuana (a politically unlikely scenario), much of our estimated savings could be shifted to the Medicaid program as payments for medical marijuana.

We studied prescribing behavior aggregated to the drug, state, and quarter level. To avoid an ecological fallacy, we did not attempt to draw inferences about individual Medicaid enrollees' behavior.<sup>25</sup> However, our findings do raise important questions about individual behavior. For example, it is plausible that forgoing medications with known safety, efficacy, and dosing profiles in favor of marijuana could be harmful under some circumstances. In addition, patients who switch from a prescription drug that requires regular physician monitoring to marijuana may interact with their doctor less often, and their adherence to other important treatment regimens could suffer. An important next step in the agenda for medical marijuana law researchers will be to secure data on individual patients over time to assess these and related questions. ■

[Published online April 19, 2017].

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- 16 Determining when a dispensary became available is complex. Some states' dispensaries sell marijuana to residents of neighboring states who have a valid medical marijuana card from their home state, which implies that some people have access to medical marijuana before a dispensary opens in their state. We estimated versions of our models that defined the presence of a medical marijuana law as being either after the date of implementation of a law that permitted home cultivation or as of the date that a dispensary opened in a state whose law required the use of a dispensary. The direction of associations in those models between laws and Medicaid prescription use were the same as—and the associations were significant and approximately three times larger than—the associations we present in the article. To avoid overstating the strength of the findings and to be consistent with previous literature (see Note 14), we chose to present the more conservative results in the text.
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