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Research paper

Do medical cannabis laws encourage cannabis use?

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Abstract

Medical cannabis is a contentious issue in the United States, with many fearing that introduction of state laws will increase use among the general population. The present study examined whether the introduction of such laws affects the level of cannabis use among arrestees and emergency department patients. Using the Arrestee Drug Abuse Monitoring system, data from adult arrestees for the period 1995–2002 were examined in three cities in California (Los Angeles, San Diego, San Jose), one city in Colorado (Denver), and one city in Oregon (Portland). Data were also analysed for juvenile arrestees in two of the California cities and Portland. Data on emergency department patients from the Drug Abuse Warning Network for the period 1994–2002 were examined in three metropolitan areas in California (Los Angeles, San Diego, San Francisco), one in Colorado (Denver), and one in Washington State (Seattle). The analysis followed an interrupted time-series design. No statistically significant pre-law versus post-law differences were found in any of the ADAM or DAWN sites. Thus, consistent with other studies of the liberalization of cannabis laws, medical cannabis laws do not appear to increase use of the drug. One reason for this might be that relatively few individuals are registered medical cannabis patients or caregivers. In addition, use of the drug by those already sick might "de-glamorise" it and thereby do little to encourage use among others.

Keywords: Medical cannabis; Arrestee Drug Abuse Monitoring program; Drug Abuse Warning Network; Cannabis use; Drug control policy

Introduction

There are currently 12 states in the USA with laws that remove penalties for the cultivation, possession and use of cannabis for medical reasons (Alaska, California, Colorado, Hawaii, Maine, Maryland, Montana, Nevada, Oregon, Rhode Island, Vermont and Washington) (Drug Policy Alliance, 2006; NORML, 2006). In most cases the law allows a written or oral recommendation by a physician stating that the patient will benefit from use of cannabis to serve as a medical necessity defense should the patient be arrested on charges of cannabis possession. These so-called "effective" laws differ from medical cannabis research laws and "symbolic" laws, such as Arizona's Proposition 200, which do not accord the same legal protection to patients who use cannabis (Pacula, Chriqui, Reichmann & Terry-McElrath, 2002; Schmitz & Thomas, 2004).

Medical use of cannabis has become an increasingly contentious issue as it is the primary arena in which the forces on either side of the prohibition-legalization debate engage one another, with both sides seeing the introduction of state laws as an initial step on the road to decriminalization of the drug (Clark, 2000; Schrag, 2002; Stein, 2002). The federal government vehemently opposes state-level introduction of medical cannabis laws on a number of grounds, including a fear that they have the potential to increase use among the general population (especially young people) through sending the message that cannabis use is acceptable (Clark, 2000; Medical Marijuana ProCon, 2006; Schrag, 2002). Moreover, this "wrong message" argument is not confined to the federal government. The authors of the 1999 Institute of Medicine Report observed that "almost everyone" that spoke to its study team "about the potential harms posed by medical marijuana felt that it would send the wrong message to children and

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teenagers". The Report goes on to state that: "The question here is not whether marijuana can be both harmful and helpful but whether the perception of its benefits will increase its abuse. For now any answer to the question remains conjecture. Because marijuana is not an approved medicine, there is little information about the consequences of its medical use in modern society" (Institute of Medicine, 1999, p. 101).

If the "wrong message" hypothesis is correct, one would anticipate greater use of cannabis and attendant problems to follow the passage of a state's medical cannabis law. We address this issue by examining trends in cannabis use among two high risk subgroups (arrestees and emergency department patients) from the mid-1990s through 2002 in five cities and five metropolitan areas in states that had passed medical cannabis laws in the previous 10 years.

Methods

Study design and data analyses

Data on cannabis use among arrestees were extracted from the Arrestee Drug Abuse Monitoring (ADAM) system which was established (as the Drug Use Forecasting program) by the National Institute of Justice in 1987 and ran until 2003 (National Institute of Justice, 1990, 2004). Twenty-three of the 38 ADAM sites active at the time that the program was discontinued had been in the program long enough to provide a sufficient number of data points to use in time-series analysis. Of these 23 cities, five were in states with effective medical cannabis laws—three in California, one in Oregon and one in Colorado.

Data on cannabis use among emergency department patients were extracted from the Drug Abuse Warning Network (DAWN) for the period 1994–2002. DAWN was established by the Substance Abuse and Mental Health Services Administration (SAMHSA) of the US Department of Health and Human Services in 1972, and substantially revised in 1988 and 2003 (Caulkins, Ebener & McCaffrey, 1995; Harrison, 1992; Substance Abuse and Mental Health Services Administration, 2002). Five of the 21 DAWN metropolitan areas are in states that introduced medical cannabis laws before 2002 (Maryland's law was introduced after this date). Three of these metropolitan areas are in California (Los-Angeles/Long Beach, San Francisco and San Diego), one in Colorado (Denver), and one in Washington State (Seattle). In general, the metropolitan areas included in DAWN are larger than individual cities and include the major city and its surrounding counties or suburbs.

The data analysis followed an interrupted time-series design, in which observations prior to an intervention (in this case, a law) are compared to those that occur afterwards (Cook & Campbell, 1979). This is one of the few designs available to assess full coverage interventions (such as state-wide laws) in which it is difficult to identify suitable units of analysis to act as a comparison condition (Rossi, Freeman & Lipsey, 1999). In the present instance, while there are ADAM and DAWN sites in states without medical cannabis laws, these are not suitable controls for the sites in the medical cannabis states since the dynamics of cannabis use vary even among states within the same region of the country (Golub & Johnson, 2001). Thus, using internal pre-law versus post-law comparisons (as done in a time-series analysis) is more appropriate than making comparisons across cities with very different patterns of drug use over time.

The basic idea that is tested in a time-series analysis is that if the law in question has an impact (either positive or negative) then the series of observations that follow its implementation will have a different slope or trend to those that occurred before (Cook & Campbell, 1979). Specifically, the focus of the present analysis was on the proportion of arrestees or emergency room patients "positive" for cannabis prior to the implementation of the medical cannabis law in each state versus the proportion following its implementation. If the law has the type of negative impact suggested by the "wrong message" argument, one would expect an increase in this proportion to follow the passage of the law.

A logit transformation was used to normalise both the ADAM and DAWN data so that standard ARIMA models could be used. All models were estimated using the ARIMA routines (Chatfield, 2004) available in the Stata statistical package, using lags that were specific to each model (StataCorp, 2005). The portmanteau statistic was used to test for residual autocorrelation (Chatfield, 2004). In the models, the variable "level" is an indicator variable defined as 0 prior to implementation of the law and 1 after the law went into effect. The variable "trend" is an interaction term computed as the product of time and level. All models were adjusted for the natural logarithm of the total number of arrestees from quarter to quarter.

Details of each state's medical cannabis laws are presented in Table 1, along with the names of the ADAM cities and DAWN metropolitan areas and the number of pre-law and post-law quarterly data points used in the time-series analysis in each state.

ADAM and DAWN datasets

As their titles imply, one of the primary purposes of developing the ADAM and DAWN programs was to use data to forecast, monitor and warn of trends in drug use. As stated on its website, "DAWN is an indicator system" and the data it contains, when used in conjunction with other indicators, "can help identify emerging trends in drug abuse at the local and national level" (Drug Abuse Warning Network, 2002). Likewise, one of the primary purposes of developing the ADAM program was to use data to forecast trends in drug use, not only in the criminal population, but also in the general population (Mieczkowski, 1996; National Institute of Justice, 1993; Wish & Gropper, 1990). This forecasting function is

Table 1
State medical cannabis laws in sites included in the ADAM program and DAWN

State	Legislation/initiative	Date effective	DAWN metropolitan areas	ADAM cities	Pre-laws data points[a]			Post-law data points		
					D	A-A	A-J	D	A-A	A-J
California	Proposition 215	6 November 1996	Los Angeles/Long Beach	Los Angeles	12	7	7	24	25	23
			San Diego	San Diego	12	7	7	24	25	23
			San Francisco	–	12	–	–	24	–	–
			–	San Jose	–	7	–	–	25	–
Colorado	Amendment 20	30 June 2001	Denver	Denver	30	26	–	5[b]	6	–
Washington	Initiative measure 692	3 November 1998	Seattle	–	20	–	–	16	–	–
Oregon	Ballot measure 67	3 December 1998	–	Portland	–	16	16	–	16	11

[a] D, DAWN dataset; A-A, ADAM adult dataset; A-J, ADAM juvenile dataset.
[b] The Colorado DAWN dataset ended at the third quarter of 2002 not the fourth quarter.

premised on the idea that trends in drug use among high-risk sub-groups can function as a leading indicator for future use among the general population (Mieczkowski, 1996; Wish & Gropper, 1990). It is reasoned that as a drug becomes more physically, socially and/or economically available those who are most "at-risk" will be first to initiate use; the use of the drug will then filter out to the general population.

The ADAM program collects data on a quarterly basis through urinalysis and self-reports in order to assess recent drug use among arrestees. At each ADAM site, trained interviewers conduct voluntary and anonymous interviews and collect urine specimens. Arrestees are approached within 48 h of their arrest and asked to participate in the study. Over the years, more than 80% of those approached each quarter in most sites agreed to the interview and, of those, about 80% agreed to give a urine specimen (National Institute of Justice, 2003a, p. 15). The analysis presented in this study was based on the urine test data, with the threshold for a positive urine analysis set at 50 ng per deciliter. All five of the cities included in the analysis provided data on adult arrestees (aged 18 years and above), and three included data from juvenile arrestees (aged 10–18 years). Juvenile data were never collected at the San Jose ADAM site, while the Colorado dataset contained only one post-law data point (making it insufficient for time-series analysis).

The ADAM dataset was obtained from the National Archive of Criminal Justice Data, which is maintained by the University of Michigan's Inter-university Consortium for Political and Social Research. The analysis was restricted to the data from 1995 to 2002, since the threshold for a positive cannabis test changed in 1995 from 100 to 50 ng per deciliter (Golub & Johnson, 2001, pp. 4–5) and the 2002 dataset was the most recent available at the time that we began the analysis. In Oregon, one data-point in the adult time-series and two in the juvenile time-series had to be imputed as raw data were missing. As shown in Table 1, there were fewer post-law data points in the juvenile dataset for both California and Oregon since the time-series ended at the second quarter of 2002 for the former and the third quarter of 2001 for the latter.

The DAWN program monitors the number of drug-related episodes by retrospectively examining records in a sample of non-Federal, short-stay general medical and surgical hospitals that operate emergency departments that are open 24 hours a day, 7 days a week (Substance Abuse and Mental Health Services Administration, 2003). The data collection procedure entails a review of medical records, not direct interviewing of patients. In each participating facility, a designated DAWN reporter reviews all available medical records to identify emergency room visits that were caused by or related to drug use. DAWN data are publicly available as half year estimates, but we used quarterly data for the period 1994–2002 obtained directly from the Substance Abuse and Mental Health Services Administration's Office of Applied Studies. The advantage of this dataset over the publicly available one was that it doubled the number of data points for the

time-series analysis; the disadvantage was that it did not break down drug mentions by age groups, meaning that we could not examine the effects of the law among younger patients. We ended the data series in 2002 since DAWN underwent a fundamental redesign in 2003 (Substance Abuse and Mental Health Services Administration, 2002).

Results

ADAM data

The average number of adult arrestees per quarter who provided urine samples was 328 in Denver (range 180–696), 285 in Portland (range 0–754), and 885 in the three California cities combined (range 382–2152). The wide range across quarters in California was due to the fact that Los Angeles contributed very little or no data to the quarterly counts for the period 2000 through 2002. While this would not affect the results for the immediate post-law period in California (1997–1999), it could influence the analysis of the longer term effects of the law. In light of this, we conducted the time-series analysis for California both with and without the data from Los Angeles. Since the results were essentially the same, the table and figure below present the analysis for all three cities. For juvenile arrestees, the average number of urine samples per quarter was 81 in Portland (range 0–260), and 255 in the two combined California ADAM sites (Los Angeles and San Diego) that included juveniles (range 74–724). As noted above, the missing values in the Portland datasets were imputed.

Fig. 1 shows the proportion of urine tests that were positive for cannabis among adult arrestees for each quarter from 1995 through 2002 for the three cities in California, as well as for Portland (Oregon) and Denver (Colorado). Following Golub and Johnson (2001), we present the data for all adult arrestees as well as "youthful" arrestees (i.e., those aged 18–20 years). There appears to be no noticeable increase in the trend following introduction of law in any of the three states, either for all adult arrestees or the youthful arrestees. This is especially noticeable in the lowess line, which uses a local regression technique to smooth the time series (Agresti, 2002).

Fig. 2 presents the same data for the juvenile arrestees in the two California cities and in Oregon. While there is a steep increase in the proportion testing positive for cannabis among Oregon juveniles in the early part of the data series, this levels off about 2 years before the introduction of the law and remains essentially flat thereafter.

To formally assess whether any change could be detected in the ADAM cannabis urine analysis data that coincided with the introduction of the medical cannabis laws, we examined the pre-law versus post-law proportion of positive tests using a series of ARIMA models. The results of these analyses are presented in Table 2. The parameter estimates for both the level and trend are shown in column 3, followed by the standard error of the coefficient, the statistical significance of

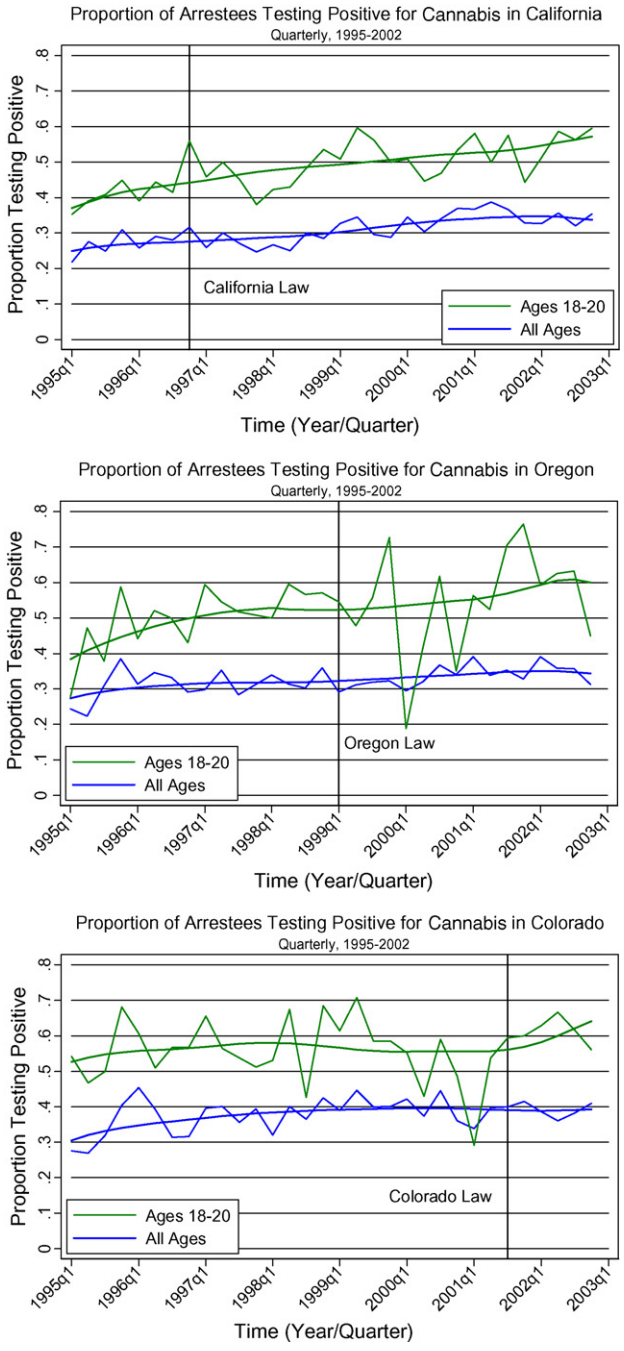

Fig. 1. Proportion of urine tests positive for cannabis among adult arrestees, 1995–2002: California, Oregon and Colorado.

the estimate, and the upper and lower boundaries of the 95% confidence interval. It can be seen that none of the parameter estimates even approached statistical significance. This was true of both the estimates of change in trend and change in level. It was also the case for the total adult sample and the youthful adult arrestees in all three states, and for the juvenile arrestees in California and Oregon. The non-significant χ^2 for the portmanteau test[19] reported in the final two columns of the table indicate that the models were successful in removing residual autocorrelation.

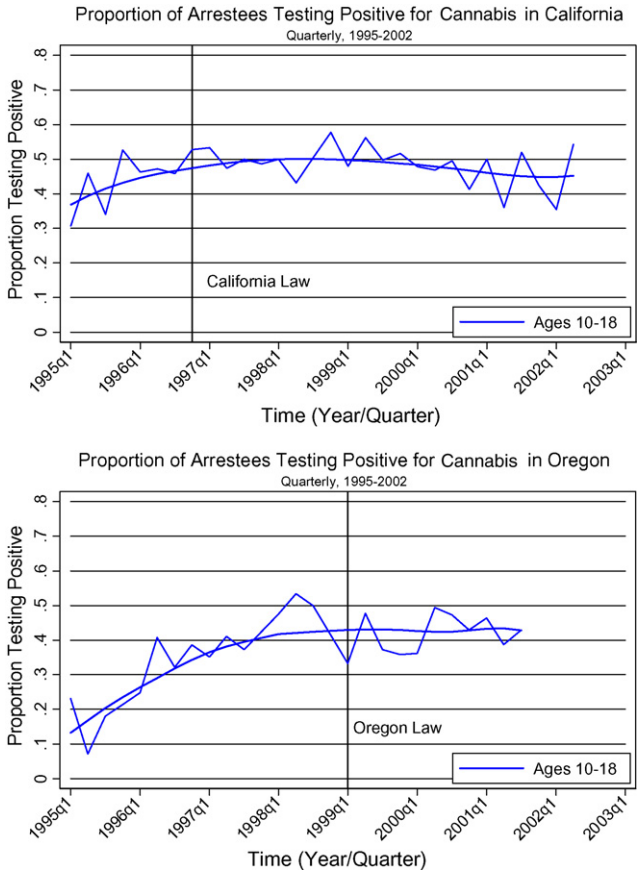

Fig. 2. Proportion of urine tests positive for cannabis among juvenile arrestees, 1995–2002: California and Oregon.

DAWN data

The samples obtained in the DAWN program were much larger than those for ADAM. The average number of emergency department visits per quarter was 121,833 in Denver (range 102,000–158,000), 155,666 in Seattle (range 132,000–197,000), and 873,750 in the three California cities combined (range 771,000–1,015,000). The outcome variable for the DAWN data was the proportion of emergency department visits in which cannabis was mentioned. Since the resulting proportions were very small, they were multiplied by 100 for all graphs as well as descriptive and inferential statistics. The inferential statistics were computed on both the proportions and the proportions multiplied by 100 and the conclusions drawn from each of these models were the same.

Fig. 3 shows the proportion multiplied by 100 of emergency department visit in which cannabis was mentioned for each quarter from 1994 through 2002 for the three cities in California, for Portland (Oregon), and for Seattle (Washington). The results of the ARIMA analysis of these trends are presented in Table 3. As with the ADAM data, none of the parameter estimates of change in trend or change in level are statistically significance.

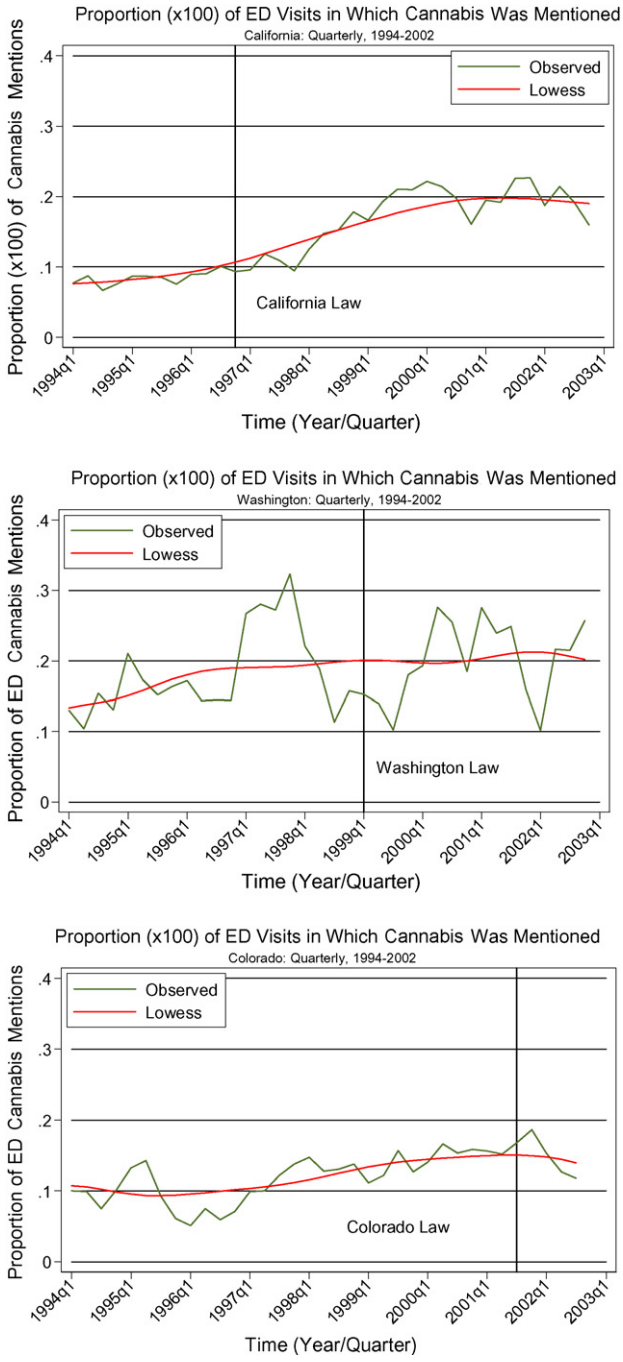

Fig. 3. Proportion of urine tests positive for cannabis among adult arrestees, 1995–2002: California, Oregon and Colorado.

Discussion

Our results indicate that the introduction of medical cannabis laws was not associated with an increase in cannabis use among either arrestees or emergency department patients in cities and metropolitan areas located in four states in the USA (California, Colorado, Oregon and Washington). For the arrestee data, the results are most persuasive for California and Oregon since the post-law time-series in these states were

Table 2
Time-series (ARIMA) models of the proportion of urine tests positive for cannabis in ADAM sites, 1995–2002

State (age group)	Coefficient	Standard error	p-Value	95% confidence interval		White noise test	
				Lower	Upper	χ^2	p-Value
California (all adults)							
Level	−3.32	5.07	0.51	−13.25	6.61	12.14	0.52
Trend	0.02	0.04	0.52	−0.05	0.09		
California (adults18–20)							
Level	−5.30	33.63	0.88	−71.22	60.62	15.68	0.27
Trend	0.04	0.23	0.88	−0.42	0.49		
California (juveniles)							
Level	−9.26	22.43	0.68	−53.22	34.70	19.31	0.08
Trend	0.06	0.16	0.68	−0.24	0.37		
Oregon (all adults)							
Level	−1.53	3.20	0.63	−7.79	4.73	18.85	0.09
Trend	0.01	0.02	0.63	−0.03	0.05		
Oregon (adults 18–20)							
Level	−0.39	2.99	0.90	−6.24	5.47	8.11	0.84
Trend	0.00	0.02	0.92	−0.04	0.04		
Oregon (juveniles)							
Level	−10.18	14.56	0.49	−38.73	18.36	8.89	0.54
Trend	0.06	0.09	0.50	−0.12	0.24		
Colorado (all adults)							
Level	−2.80	29.10	0.92	−59.84	54.24	14.76	0.32
Trend	0.02	0.17	0.92	−0.32	0.36		
Colorado (adults 18–20)							
Level	26.09	20.31	0.20	−13.71	65.90	19.09	0.12
Trend	−0.15	0.12	0.20	−0.39	0.08		

fairly long. This is also true of the DAWN analysis of the California and Washington State time-series. Since we have only a short time-series for both the ADAM and DAWN Colorado dataset it is possible that the law could have a delayed effect that we are unable to identify (although neither ADAM or DAWN data can be used to assess this since the former was discontinued in 2003 and the latter substantially revised in 2003).

The fact that we observed the same pattern of results in two different datasets increases confidence in the findings presented. However, before interpreting these findings and discussing their implications, the limitations of the study (which emanate from the shortcomings of the ADAM and DAWN datasets) should first be noted. The main problem in using the ADAM dataset to test the hypothesis that medical cannabis laws encourage use of the drug is that it is limited to large metropolitan areas and to a subgroup of the population of these cities (i.e., arrestees) that most represents the socioeconomically disadvantaged and those involved in multiple problem behaviors. In addition, most crimes do not result in arrest, and arrest is most likely to occur in the case of serious crime (e.g., robbery, assault and burglary) and when a criminal is a frequent drug user (Chaiken & Chaiken, 1996). Thus, the ADAM data may not even be generalizable to all types

Table 3
Time-series (ARIMA) models of the proportion of emergency department visits in which cannabis was mentioned in California, Washington State, and Colorado DAWN sites, 1994–2002

State (age group)	Coefficient	Standard error	p-Value	95% confidence interval		White noise test	
				Lower	Upper	χ^2	p-Value
California							
Level	1.57	1.98	0.43	−2.30	5.45	17.97	0.26
Trend	−0.01	0.01	0.47	−0.04	.02		
Washington							
Level	−1.76	3.38	0.60	−8.38	4.85	13.64	0.87
	0.01	0.02	0.57	−0.03	0.05		
Colorado							
Level	12.65	29.47	0.67	−45.11	70.42	9.15	0.92
Trend	−0.08	0.18	0.67	−0.42	0.27		

of criminals, let alone non-criminals. Thus, it is possible that cannabis use increased in Oregon, Colorado and California following the passage of medical cannabis laws but that this occurred among subgroups other than arrestees and/or was concentrated in geographic areas not included in the ADAM program.

In addition, due to various sampling quotas and the fact that only booked arrestees in the facility at the time of data collection were sampled, ADAM data were not representative of all arrestees in the participating sites from 1995 through 1999 (Caulkins, 2000). Probability-based sampling was introduced for male arrestees in 2000, thereby reducing comparability with earlier years (National Institute of Justice, 2003b). Given that the medical cannabis law in Oregon was introduced in December of 1998 and the law in Colorado in June of 2000, this change in the ADAM system could affect the results presented herein for these two states.

The DAWN dataset has similar limitations that affect its generalizabilty, as well displaying inconsistencies in the application of drug definitions (Caulkins, 2000). Like ADAM, it focuses on an urban high-risk subgroup, although emergency department patients are probably more representative of the general population than arrestees. DAWN also does not collect data from all of the emergency departments in the metropolitan areas involved in the program, but rather is based on a statistical sample of these. Moreover, since it is a voluntary system, selected emergency rooms can decline to participate. Finally, in the present analysis, we were unable to examine the DAWN data for specific age subgroups, thereby preventing analysis of the effects of the law on juveniles and young adults who are most likely to initiate cannabis use.

Having stated these limitations, it should be noted that both datasets have been successfully used in describing trends in drug use across different geographic locations (Caulkins, 2001; Golub & Johnson, 2001; Harrison, 1992; Martin, Maxwell, White & Zhang, 2004), and DAWN has been previously used to assess the effects of changes in state cannabis laws (Model, 1993). Thus, while caution should be exercised when it comes to interpreting the findings from arrestees and emergency department patients, it is reasonable to assume that the ADAM and DAWN datasets can be used to assess the effects of changes in cannabis policies, at least among these high-risk subgroups of a state's population.

Given the paucity of research into the effects of changes in drug policy (including medical cannabis laws) and the reluctance of the US government to fund evaluations of such policies, the datasets used in virtually every evaluation of liberalization of cannabis laws have limitations. Thus, like any other single study in this area, the findings of the current research are most appropriately considered within the context of the broader body of research into the effects of changes in cannabis laws (MacCoun & Reuter, 1997). The US research that is available pertains almost exclusively to the decriminalization reforms of 1970s and, like our study, shows that changes in laws have little effect on cannabis use (Maloff, 1981; Single, Christie & Ali, 2000). Likewise, studies from countries other than the US suggest that liberalization of laws alone have at most a modest influence on cannabis use (Donnelly, Hall & Christie, 1995; MacCoun & Reuter, 1997).

There are at least two reasons why one might expect medical cannabis laws to have even less influence on use of the drug than decriminalization laws. First, the number of people affected by the laws is relatively small. While California has only recently introduced a voluntary registration system, both Colorado and Oregon have operated mandatory systems since the implementation of their medical cannabis laws, thereby allowing some assessment of the number of people directly affected. In Colorado, which had a 2000 population of about 4.3 million, the total number of patients in possession of a valid registration card in May of 2006 was just 780 (Colorado Department of Public Health and Environment, 2006). In Oregon, where the 2000 population was 3.4 million, 10,775 patients and 5119 caregivers held medical cannabis identification cards as of 1 April 2006 (Oregon Department of Human Services, 2006). If it is the visibility of medical cannabis users or the potential that they present to increase the availability of the drug that matters when it comes to promoting use in the general population (rather than simply the equivocal message that medical cannabis laws send), then it is unlikely that use would go up in Colorado where there is fewer than one registered user for every 5000 people. Even in Oregon there are less than five cardholders per 1000 population, so their ability to convert non-users either as role models or as a source of the drug is also probably very limited.

Second, it may be that even if the number of medical cannabis users was greater in these states this would still not have a strong influence on the decision of others to use the drug. As Bruce Mirkin of the Marijuana Policy Project observed: "Frankly, it never made any sense that kids would think a drug 'cool' because cancer or AIDS patients use it to keep from vomiting" (Marijuana Policy Project, 2004). Indeed, it might be argued that such patients "de-glamorised" the drug and thus have a negative impact on use, especially among youth. According to Musto (1993), one of the reasons that drug epidemics eventually die out is that the casualties of the early wave act as a deterrent on initiation—they become essentially a bad advertisement for the drug. Cannabis use by already sick individuals might have a similar deterrent effect, especially if an outside observer is unable to discern the nature of the relationship between use of the drug and the individual's disease (as might be the case with young people).

As noted above, the recent Institute of Medicine (1999) report observed that there is little information about the consequences of the medical use of cannabis in modern society, and therefore one can only speculate as to whether the introduction of medical cannabis laws increases use of the drug. It is hoped that the results presented herein go some way towards moving the debate beyond such speculation and conjecture. Consistent with other studies of the liberalization of cannabis laws, they indicate that medical cannabis laws do not increase use of the drug. However, our study is far

from the final word on this issue, and the effects of medical cannabis laws must be further examined with populations other than arrestees and in geographic sites other than the large metropolitan areas included in the ADAM and DAWN programs.

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