Published in final edited form as:

J Subst Abuse Treat. 2014 October ; 47(4): 245–250. doi:10.1016/j.jsat.2014.06.001.

Evidence-Based Treatment for Opioid Disorders: A 23-Year National Study of Methadone Dose Levels

Thomas D'Aunno, Ph.D.,

Columbia University, 600 W. 168th St., #03, New York, New York 10032, tdaunno@columbia.edu,
Phone: 212.305.3524, Fax: 212.305.3405

Harold A. Pollack, Ph.D.,

University of Chicago, School of Social Administration, 969 E. 60th Street, Chicago, IL 60637,
773. 702.1250, haroldp@uchicago.edu

Jemima A. Frimpong, Ph.D., and

Mailman School of Public Health, Columbia University, 600 W. 168th St., #604, New York, New York 10032, jf2584@cumc.columbia.edu

David Wuchiett, MS

Mailman School of Public Health, Columbia University, 600 W. 168th St., New York, New York 10032, dmw2154@columbia.edu

Abstract

Effective treatment for patients with opioid use problems is as critical as ever given the upsurge in heroin and prescription opioid abuse. Yet, results from prior studies show that the majority of methadone maintenance treatment (MMT) programs in the US have not provided dose levels that meet evidence-based standards. Thus, this paper examines the extent to which US MMT programs have made changes in the past 23 years to provide adequate methadone doses; we also identify factors associated with variation in program performance. Program directors and clinical supervisors of nationally-representative methadone treatment programs were surveyed in 1988 (n=172), 1990 (n=140), 1995 (n=116), 2000 (n=150), 2005 (n=146), and 2011 (n=140). Results show that the proportion of patients who received doses below 60 mg/day--the minimum recommended--declined from 79.5 to 22.8 percent in a 23-year span. Results from random effects models show that programs that serve a higher proportion of African-American or Hispanic patients were more likely to report low-dose care. Programs with Joint Commission accreditation were more likely to provide higher doses, as were program that serve a higher proportion of unemployed and older patients. Efforts to improve methadone treatment practices have made substantial progress, but 23% of patients across the nation are still receiving doses that are too low to be effective.

© 2014 Elsevier Inc. All rights reserved.

Correspondence to: Thomas D'Aunno.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Keywords

opioid disorders; methadone; dose levels; organizational correlates

How well do the nation's methadone maintenance treatment (MMT) programs meet evidence-based standards for patient care? This is a critical question for health policy and the provision of treatment services for three key reasons (SAMHSA, 2012). First, opioid abuse and dependence is a widespread and growing problem in the US (SAMHSA, 2012). Second, methadone maintenance is the primary treatment approach for opioid use disorders, and remains so even as other pharmacotherapies, such as buprenorphine and extended-release naltrexone, have become more available (H. D. Kleber, 2008; Nosyk et al., 2013). Finally, data from a 17-year longitudinal study of the nation's MMTs indicate that, in 2005, more than half of patients (51%) received doses of methadone that were too low to be effective, i.e., below 60 mg/d (Pollack & D'Aunno, 2008). In short, nationally representative data from 2005 show much room for improvement in the extent to which the nation's MMTs deliver methadone dose levels consistent with empirically established levels of efficacy.

Introduction

The number of individuals with a heroin abuse or dependence disorder increased from 214,000 in 2007 to 426,000 in 2011, a year in which there were 178,000 new users of heroin (SAMHSA, 2012). There also have been marked increases in the abuse and dependence of non-heroin opioids: between 2004 and 2011, the number of individuals dependent on or abusing opioid analgesics, such as oxycodone and hydrocodone, increased from 1.4 million to 1.8 million. Further, opioid overdose is now the second leading cause of accidental death in the US-surpassed only by motor vehicle accidents (CDC, 2013).

Injection drug use and other HIV risk behaviors also are strongly associated with opioid use. Thus, despite some decline in HIV incidence among injection drug users, an estimated 9% of new U.S. HIV infections in 2009 occurred among injecting drug users (CDC, 2009).

The prevalence of opioid abuse and dependence in the US population is reflected in the number of individuals receiving treatment in the nation's 1223 methadone maintenance treatment programs: 306,440 patients received treatment in these programs in 2011, accounting for about 26% of all admissions to substance abuse treatment programs in the U.S (SAMHSA, 2012). Admissions to treatment involving abuse of opioid analgesics, in particular, increased from 5,032 in 2000 to 33,701 in 2010 (SAMHSA, 2012).

There is substantial and long-standing evidence of methadone treatment's effectiveness in numerous studies conducted across several continents (Amato et al., 2005), including randomized clinical trials (Newman & Whitehill, 1979; Strain, Bigelow, Liebson, & Stitzer, 1999) and multi-site longitudinal studies (Simpson, Joe, & Brown, 1997). Results from clinical trials as well as prospective cohort studies show that methadone treatment is effective in reducing opioid use (Faggiano, Vigna-Taglianti, Versino, & Lemma, 2003), overdose death, drug injection, HIV risk behavior and HIV sero-conversion (Des Jarlais & Semaan, 2008). A Cochrane review of rigorously conducted random control trials

comparing methadone treatment to non-pharmacological treatments found that methadone was significantly more effective than non-pharmacological approaches in retaining patients in treatment and in reducing heroin use (B. C. Mattick RP, Kimber J, Davoli M., 2009). Using data from 24 random control trials, a separate Cochrane review compared methadone to buprenorphine maintenance treatment and concluded that methadone was more effective than buprenorphine when delivered at adequate doses (K. J. Mattick RP, Breen C, Davoli M., 2008).

There is considerable evidence that the effectiveness of methadone treatment depends on providing an adequate dose (Faggiano et al., 2003). Evidence suggests that MMT programs should provide average doses of methadone in the range of 80–100 mg/day. Strain (2006) summarized 11 double-blind random control trials conducted between 1971 and 2000 (Johnson et al., 2000) that compared the effectiveness of different methadone doses, and concluded that benefits such as reduced opioid use and increased retention in treatment depend on daily doses of 80 mg and higher (Institute of Medicine, 1994; H. D. Kleber, 2008).

A potential confusion in methadone treatment arises from the need to individualize dose levels while ensuring therapeutic dose levels. On the one hand, methadone dosage should be determined individually because of differences in metabolism. On the other hand, results from the key studies summarized above show that patients who take daily doses of methadone that exceed 80mg/day, and who maintain an average plasma concentration of about 400ng/mL, engage in relatively little illicit drug use and have better treatment outcomes.

In fact, no studies have found that the relationships among methadone dose levels, retention in treatment, and treatment outcomes are mitigated by the need to individualize dose levels. Although optimal dose levels may vary somewhat from one individual to another, there is no evidence that these variations should prevent MMT programs from providing average doses in the range of 80–100 mg/day.

Nonetheless, data from a 17-year longitudinal study of the nation's MMTs indicate that, in 2005, only 44% of patients received doses of at least 80mg/day (D'Aunno & Pollack, 2002; D'Aunno & Vaughn, 1992; Pollack & D'Aunno, 2008). More than half of patients (51%) received doses that prior studies show are ineffective, i.e., below 60 mg/d-- 34% of patients received doses below 60 mg/day, while 17% received doses below 40 mg/day.

Given prior data on the performance of the nation's MMTs; lack of nationally representative data since 2005; increased need for effective treatment of opioid abuse disorders (Nosyk et al., 2013); and prior controversy about methadone treatment (H. D. Kleber, 2008), as well as major efforts to improve treatment practices (Institute of Medicine, 1994), this paper addresses two questions. First, to what extent are the nation's MMTs meeting evidence-based standards of care for methadone dose level? Second, what characteristics of treatment programs are associated with variation in their performance?

To address this second question, we draw on prior research which indicates that variation in the methadone dose levels that MMTs provide is related to variables in three key categories:

(1) patient characteristics; (2) program characteristics, including ownership, payment (i.e., managed care arrangements), accreditation and staff background; (3) managerial attitudes and beliefs that may run counter to the use of evidence-based practices (Pollack & D'Aunno, 2008).

Methods

This study uses data from six waves of a longitudinal, panel survey conducted in 1988 (n=172), 1990 (n=140), 1995 (n=116), 2000 (n=150), and 2005 (n=146) by the University of Michigan's Institute for Social Research, and in 2011 (n=140), by Cornell University's Survey Research Institute. The response rate for each NDATSS wave exceeded 80 percent, varying from a low of 82% in 1988 to 92% in the year-2000 wave (Adams, 2005; Adams TA & Heeringa SG, 2001).

Sampling frame and sample

We define a methadone maintenance treatment (MMT) program as a physical facility with resources dedicated specifically to treating opiate dependence through methadone. Because the Food and Drug Administration, and now the Substance Abuse and Mental Health Services Administration (SAMHSA), license all MMTs, we obtained lists that precisely identify the entire US population of approved MMTs. In 2007, SAMHSA (2009) reported that there were 1,108 licensed MMTs, a number that had remained relatively stable since 1999. By 2011, this population had increased to 1223 methadone-dispensing treatment programs.

For the 2011 survey wave, we contacted a random subsample of MMTs that participated in 2005 and a random subsample of MMTs from SAMHSA's 2011 list. The purpose of adding this subsample to the sub sample of panel units was to ensure that the 2011 cross-section as a whole was representative of the population of MMTs: the panel sample alone would not have represented programs founded since 2005 and these younger programs might differ from older programs. Of all the 2005 and newly-selected MMTs contacted in 2011, 140 completed surveys and 15 refused, for a response rate of 90%.

We conducted extensive analyses to assess possible non-response bias stemming from 15 MMTs that refused to participate in the 2011 study. Specifically, we compared responding MMTs to non-participating MMTs along 20 key variables (e.g., ownership; methadone dose levels in 2005) and did not find a single statistically significant difference. Similarly, we had conducted analyses at each of the survey waves prior to 2011 to determine if participating programs differed from non-participants; results showed no significant differences (D'Aunno & Pollack, 2002; Pollack & D'Aunno, 2008).

Analyses also showed that the programs added to the sample in 2011 (n=77) differed significantly from the panel programs (n=63) in only two ways. First, the programs added to the sample were significantly younger than panel programs. Second, the programs added to the sample in 2011 were significantly less likely to have patients with methadone doses of less than 40 mg/d (the panel sample had a mean percentage of 12.9 patients receiving < 40 mg/d vs. 9.6% of patients receiving < 40 mg/d in the programs added to sample). This

indicates that a portion, though not much, of the observed changes in methadone dose levels reported below is due to the new programs added to the NDATSS sample.

Data collection, reliability and validity

This study was approved by the Institutional Review Boards of our universities. The director and supervisor of clinical services of each participating program completed telephone surveys; informed consent to participate in the study was obtained orally prior to administering the surveys. We followed established methods that maximize reliability and validity in phone surveys (Groves, 1988). These methods include: pre-testing the survey with a random sample of 10 programs; providing training about our study for telephone interviewers who already have been trained at Cornell's Survey Research Institute; sending each program director a cover letter explaining the study, along with web-based work-sheets that inform participants of the requested data and enable them to consult financial and administrative records prior to the call; and making a brief phone call to follow-up on the letter.

Further, as data are collected, we perform extensive computer reliability checks to signal interviewers of inconsistent or infeasible responses (e.g., % of patients with various demographic characteristics should sum to 100%). Interviewers then work with respondents to resolve inconsistencies. Results are further scrutinized for reliability and validity. Reliability checks include comparisons of reported totals (e.g., total revenue) with the sum of reported detail (e.g., revenues by source); comparison of responses to related questions; comparison of responses between director and supervisor; and, for panel programs, comparison of responses over time. Results from several analyses provide support for NDATSS data reliability and validity (see Appendix A) (Pollack & D'Aunno, 2008).

Variables

Methadone treatment practices: Using data from clinical supervisors, we calculated the percentage of patients in each treatment program who received doses that were below 40, 60, or 80 mg/day. These measures were calculated only for patients who had been receiving the same methadone dose for at least 2 weeks. They therefore measure the dose level that programs dispense for patients whose dose levels have stabilized.

Patient characteristics: Prior research indicates that patient characteristics are related to methadone dose levels (D'Aunno & Pollack, 2002; Pollack & D'Aunno, 2008). Clinical supervisors reported 3 important characteristics of patient mix: race/ethnicity (percentage of African American and Hispanic/Latino patients); employment status (percentage of patients who are currently unemployed); patient age (percentage of patients aged 40 or above). These measures are characteristics of the mix of patients at the program level of analysis; we do not have data from individual patients.

Program characteristics: Prior research also indicates that key characteristics of programs are related to dose levels (D'Aunno & Pollack, 2002; Pollack & D'Aunno, 2008). Directors reported program ownership (public, private for profit, private not-for-profit; we used public as the referent category) and we also used data from program directors to measure if the

program was accredited by either the JCAHO or the Commission on Accreditation of Rehabilitation Facilities (CARF) (1=yes; 0=no). Following Pollack and D'Aunno (2008) (Pollack & D'Aunno, 2008), we used data from clinical supervisors to measure the percentage of staff members who are ex-addicts.

We examined the impact of managed care stringency on dose levels. Following prior work (Lemak & Alexander, 2001), we define managed care stringency as the proportion of patients requiring pre-authorization of services. Clinical supervisors reported the percentage of patients whose payment sources required authorization before patients could begin treatment. Finally, clinical supervisors reported the number of methadone patients in treatment.

Managerial attitudes: Prior studies (Caplehorn, Lumley, & Irwig, 1998; Pollack & D'Aunno, 2008) indicate that many managers and staff members in MMTs hold beliefs and values that run counter to best practices, especially views about abstinence approaches to recovery and lack of support for harm reduction or other approaches to HIV prevention. Thus, using 5-point Likert scales, program directors reported the extent to which they support the effectiveness of abstinence approaches to recovery (1=no extent; 5=a very great extent) and oppose syringe exchange (a measure of support for abstinence). Similarly, directors also reported the extent to which they support the provision of HIV prevention information to injection drug users and the extent to which their program includes staff who work specifically on HIV prevention (1=no extent; 5=a very great extent). For the latter variable, we characterize MMT programs as having limited commitment to HIV prevention if directors indicate “no extent” or “a limited extent” of staff dedicated to this task.

Control for geography and time effects: We controlled for geographic location using a census division scale (Northeast, Midwest, South and West), with the Northeast serving as the referent category. To capture time effects, we created dummy variables corresponding to the year in which survey data were collected, with 2011 serving as the referent year.

Data analysis

This study uses a longitudinal, panel design. This design is most effective for examining changes in treatment practices and their correlates over time. Yet, repeated observations of the same programs over time; potential nonresponse bias; and unobserved differences among programs complicate panel data analysis. We address these issues as follows.

First, many MMTs in our sample participated in several survey waves and we must therefore account for repeated observations from the same MMT over time. To do so, we use random-effects regression analyses that account for the possibility of within-unit clustering over time (Diggle, Liang, & Zeger, 1994).

Second, random-effects models also are helpful to mitigate bias due to nonrandom attrition of programs from the sample over time. In the presence of nonrandom attrition, naïve analysis using only the data from programs that participated in all 6 surveys can produce biased results (Little, 2002). We thus used all available data from each survey wave, including data from MMTs that participated in some years but not in others.

Third, unobserved differences among programs may influence our analyses. Methadone doses within the same treatment programs, for example, are likely to be correlated due to unobserved characteristics of these same programs. We capture many such factors in our multivariate model, but important program characteristics are unobserved— such as features of local drug markets. Because these unobserved characteristics are likely to be stable over time, and because we wish to examine the impact of observed characteristics such as client case-mix, and program ownership, a random-effect regression specification is appropriate for our data (Hsiao, 2003).

This random-effects specification relies on the important assumption, however, that unobserved, stable program characteristics are not correlated with the observed characteristics included in our models. Yet, this assumption might not hold. For example, patients with more severe problems, which we do not measure, may require higher doses and may congregate in public treatment programs. Because such patterns could potentially induce bias, we scrutinized our random-effect specification using a Hausman test.

The Hausman test compares the results from random-effects analysis with results from a fixed-effects model that allows for the possibility that program characteristics that we did not measure (e.g., severity of addiction) are correlated with the observed covariates (e.g., patient race/ethnicity) (Hsiao, 2003). If the random-effects model is correctly specified, the two approaches will yield consistent point estimates for all time-varying covariates. If point estimates from the two models yield statistically (and clinically) significant differences, unobserved heterogeneity may bias the random-effect coefficients. Results from the Hausman test were not significant, suggesting that our random-effects model is correctly specified.

Finally, some independent variables (in particular, percent of patients requiring prior authorization) displayed missing observations in particular survey waves. When a given MMT displayed missing values for these variables, we imputed values by calculating predicted values using multiple regression analysis based on dummy variables for the NDATSS survey wave and the observed values of these variables within the same MMT program in other waves. This imputation had no substantive impact on our point estimates, but increased our sample size in pooled regression analysis from 761 to 864 programs. Analyses were performed using Stata Version 12 (StataCorp, 2011).

Results

Table 1 presents descriptive data for all the study variables. Table 2 shows the percentage of patients receiving mean methadone maintenance doses of less than 40, 60 and 80 mg/d, by year within the study sample; these data are weighted by program size to capture the experience of the typical patient. Table 3 below presents results from random effects regression models using national data from 1988 to 2011.

Between 1988 and 2011, we observed large declines in the prevalence of low dosing. The proportion of patients who received doses below 60 mg/day— the minimum recommended by the Institute of Medicine, by consensus panels, and by Cochrane collaboration results—

declined from 79.5 to 22.8 percent in this 23-year span. We observed a similar decline in the proportion of patients receiving doses below 40mg/day: 44.8% in 1988 vs. 10.4% in 2011. We also found a rising proportion of patients receiving doses that exceed 80 mg/day. Indeed, by 2011, more than half (59.3 percent) of patients received at least 80mg/day, the range marked as most effective by Strain's review (Strain E.C, 2006).

Table 3 shows the results from random-effect regression models for our pooled sample of 1988–2011 data. We find several significant associations between the dose levels that programs provide, on average, and key characteristics of patients, programs, and managers.

Time trends and patient characteristics

Consistent with the pattern we observe in Table 2, the results show significant time trends toward higher dose levels. Yet, for the year 2005, the only significant difference is for the percentage of patients receiving dose levels of 80 mg/d, indicating that since 2005 more programs are now providing doses at the level that randomized control studies find most effective. Further, programs that treat higher percentages of African-Americans and Hispanic patients are more likely to provide low doses and less likely to provide higher doses. The results also show that programs with higher percentages of unemployed patients are more likely to provide dose levels greater than 80 mg/day; similarly, programs with older patients (age 40 and above) are more likely to provide dose levels greater than 60 or 80 mg/day.

Program characteristics

Consistent with prior findings, programs with JCAHO accreditation are more likely to provide higher doses (D'Aunno & Pollack, 2002; Pollack & D'Aunno, 2008). Compared to programs located in the Northeast, programs in the Midwest and South were more likely to provide doses below 40 mg/d

Managerial attitudes

Finally, to the extent that managers oppose aggressive HIV prevention efforts (i.e., syringe exchange), programs are less likely to provide high methadone doses (> 80 mg/day).

Discussion

The period 1988–2011 marked a sharp reduction in methadone under-dosing practices among the nation's MMT programs. Yet, in 2011, 22.8% of patients across the nation (about 70, 000 individuals) still received doses that were below recommended levels (< 60 mg/d) and only 59 percent of methadone patients in surveyed treatment programs received doses of at least 80mg/day—the threshold identified as recommended practice in a review of 11 random control trials of the effectiveness of various dose levels (Strain E.C, 2006).

We find some noteworthy differences from earlier results. JCAHO accreditation—an important variable in predicting methadone dose levels across the 23-year study--was statistically significant, but less important, in the results reported here compared to results from prior studies (D'Aunno & Pollack, 2002; Pollack & D'Aunno, 2008). Perhaps JCAHO

accreditation is less important as a predictor of high methadone doses because accreditation became mandated after 2000. In other words, MMTs that sought JCAHO accreditation prior to 2000 may differ substantially from programs that only more recently were required to have either JCAHO or CARF accreditation. Specifically, it is possible that, compared to other programs, the earlier wave of JCAHO-accredited programs were more motivated to improve quality of care and were relatively resource-rich (e.g., in funds, staff, and training). These factors, either singly or in combination, may have enabled JCAHO-accredited programs to be technology leaders that responded earlier to research documenting the benefits of high methadone doses.

The continued strong tie between the proportion of a program's patients who are from racial minority groups and methadone dose is clearly a concern (D'Aunno & Pollack, 2002; D'Aunno & Vaughn, 1992; Pollack & D'Aunno, 2008). Programs that treat a high percentage of African American and Hispanic patients are much more likely than programs that treat a higher percentage of non-Hispanic whites to provide doses below all recommended levels, including 40, 60 and 80 mg/d. We know of no clinical studies that demonstrate that nonwhite methadone patients systematically prefer or achieve better outcomes on low-dose treatment.

Rather, it is more likely that common underlying weaknesses in treatment programs are at work in our results. Programs that provide low doses may lack human and financial resources (well-trained, well-paid, and stable work forces) or management systems (information systems; quality of care indicators and systematic checks of these) that contribute to their inability to meet care standards. The results reported here do not take into account these and other characteristics of organizations and their managers or clinical staff members, such as their education, that could be related to dose levels. Examining these factors should be a priority, especially in studies that are not limited—as ours is—by a lack of patient-level data.

We also are struck by the connection between managerial attitudes and methadone dose levels. Managers who oppose aggressive harm reduction efforts (syringe exchange) are more likely to be in programs that also provide low doses. After decades of experience, basic differences about the proper goals of methadone treatment and the role of MMT programs in HIV prevention continue to influence clinical practice, underscoring the contested role of methadone treatment for opiate disorders (H. D. Kleber, 2008).

Nonetheless, it appears that a variety of efforts over a period of many years to increase methadone dose levels have produced significant improvements. These efforts include an Institute of Medicine report (Rettig, 1995); a National Institute of Health consensus panel (National Institute of Health, November 17–19, 1997); numerous clinical studies of effective dose levels, as well as systematic summaries of these studies (Amato et al., 2005; Strain E.C, 2006); wide-spread dissemination of treatment guidelines by the Center for Substance Abuse Treatment (CSAT), which is part of SAMHSA; studies of the quality of opioid treatment funded by the National Institute on Drug Abuse (Nosyk et al., 2013); and a shift in regulatory authority from the Drug Enforcement Agency to CSAT. Unfortunately, it is not clear what role, if any, these interventions have played individually, or in combination, in

improving methadone dose levels. But, given that 23 percent of patients in the nation's MMT programs are still receiving doses that are too low to be effective, policy-makers and managers should emphasize the need for programs with low dose levels to carefully evaluate patient outcomes and take appropriate action.

Acknowledgments

This study was supported by NIDA grant 1R01DA030459, Thomas D'Aunno, Ph.D., principal investigator.

References

- Adams, TK. Survey Research Center, Institute for Social Research. Ann Arbor: University of Michigan; 2005. Outpatient Substance Abuse Treatment Surveys (OSATSS) sampling and weighting documentation for OSATSS-6, 2004.
- Adams, TA.; Heeringa, SG. Outpatient Substance Abuse Treatment System Surveys (OSATSS): Technical Documentation for OSATSS-5, 1999–2000. Ann Arbor: Institute for Social Research, Survey Design and Analysis Unit, University of Michigan; 2001.
- Amato L, Davoli M, Perucci CA, Ferri M, Faggiano F, Mattick RP. An overview of systematic reviews of the effectiveness of opiate maintenance therapies: available evidence to inform clinical practice and research. *J Subst Abuse Treat*. 2005; 28(4):321–329. [PubMed: 15925266]
- Caplehorn JR, Lumley TS, Irwig L. Staff attitudes and retention of patients in methadone maintenance programs. *Drug Alcohol Depend*. 1998; 52(9788007):57–61. [PubMed: 9788007]
- CDC. HIV Infection and HIV-Associated Behaviors Among Injecting Drug Users — 20 Cities, United States. *Morbidity and Mortality Weekly*. 2009; 61(08):133–138. Retrieved March, 2, 2012, from <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6108a1.htm>.
- CDC. Vital signs: Overdoses of prescription opioid pain relievers—United States, 1999–2008. *Morbidity and Mortality Weekly Report*. 2013. Retrieved June 3, 2013, from <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6043a4.htm>
- D'Aunno T, Pollack HA. Changes in methadone treatment practices: results from a national panel study, 1988–2000. *JAMA*. 2002; 288(7):850–856. [PubMed: 12186602]
- D'Aunno T, Vaughn TE. Variations in methadone treatment practices. *JAMA: the journal of the American Medical Association*. 1992; 267(2):253–258. [PubMed: 1727522]
- Des Jarlais DC, Semaan S. HIV prevention for injecting drug users: the first 25 years and counting. *Psychosom Med*. 2008; 70(5):606–611. [PubMed: 18519886]
- Diggle, P.J.; Liang, KY.; Zeger, SL. *Analysis of Longitudinal Data*. Oxford, UK: Oxford University Press; 1994.
- Faggiano F, Vigna-Taglianti F, Versino E, Lemma P. Methadone maintenance at different dosages for opioid dependence. *Cochrane Database Syst Rev*. 2003; (3):CD002208. [PubMed: 12917925]
- Groves, RM. *Telephone Survey Methodology*. New York: Wiley and Sons; 1988.
- Hsiao, Cheng. *Analysis of Panel Data*. Second ed.. Cambridge, UK: Cambridge University Press; 2003.
- Institute of Medicine. *Federal regulation of methadone*. 1994
- Johnson RE, Chutuape MA, Strain EC, Walsh SL, Stitzer ML, Bigelow GE. A comparison of levomethadyl acetate, buprenorphine, and methadone for opioid dependence. *N Engl J Med*. 2000; 343(18):1290–1297. [PubMed: 11058673]
- Kleber HD. Methadone maintenance 4 decades later: thousands of lives saved but still controversial. *JAMA*. 2008; 300(19):2303–2305. [PubMed: 19017918]
- Kleber, HD. The National Evaluation of Substance Abuse Treatment study; Paper presented at the College on Studies of Drug Dependence, 62nd Annual Meeting; San Juan, Puerto Rico. 2000.
- Lemak CH, Alexander JA. Managed care and outpatient substance abuse treatment intensity. *J Behav Health Serv Res*. 2001; 28(11329996):12–29. [PubMed: 11329996]
- Little, R.; Rubin, D. *Statistical analysis with missing data*. New York: Wiley-Interscience; 2002.

- Mattick RP, Breen C, Kimber J, Davoli M. Methadone maintenance therapy versus no opioid replacement therapy for opioid dependence. *Cochrane Database of Systematic Reviews* (3). 2009
- Mattick RP, Kimber J, Breen C, Davoli M. Buprenorphine maintenance versus placebo or methadone maintenance for opioid dependence. *Cochrane Database of Systematic Reviews*(2). 2008
- National Institute of Health. (November 17–19, 1997). Consensus statement 108: Effective medical treatment of opiate addiction. Retrieved August 23, 2013, from <http://consensus.nih.gov/1997/1998TreatOpiateAddiction108html.htm>
- Newman, Robert G, Whitehill, Walden B. Double-Blind Comparison Of Methadone And Placebo Maintenance Treatments Of Narcotic Addicts In Hong Kong. *The Lancet*. 1979; 314(8141):485–488. doi: [http://dx.doi.org/10.1016/S0140-6736\(79\)91550-2](http://dx.doi.org/10.1016/S0140-6736(79)91550-2).
- Nosyk B, Anglin MD, Brissette S, Kerr T, Marsh DC, Schackman BR, Montaner JS. A call for evidence-based medical treatment of opioid dependence in the United States and Canada. *Health Aff (Millwood)*. 2013; 32(8):1462–1469. [PubMed: 23918492]
- Pollack HA, D'Aunno T. Dosage patterns in methadone treatment: results from a national survey, 1988–2005. *Health Serv Res*. 2008; 43(6):2143–2163. [PubMed: 18522665]
- Rettig, RA.; Yarmolinsky, A. *Federal Regulation of Methadone Treatment*. Washington, DC: National Academy Press; 1995.
- SAMHSA. Rockville, MD: 2012. Results from the 2011 National Survey on Drug Use and Health: Summary of National Findings, NSDUH Series H-44, HHS Publication No. (SMA) 12-4713.
- Simpson D, Dwayne Joe, George W, Brown, Barry S. Treatment retention and follow-up outcomes in the Drug Abuse Treatment Outcome Study (DATOS). *Psychology of Addictive Behaviors*. 1997; 11(4):294–307.
- StataCorp. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP. 2011
- Strain EC, Bigelow GE, Liebson IA, Stitzer ML. Moderate- vs high-dose methadone in the treatment of opioid dependence: a randomized trial. *JAMA*. 1999; 281(10086434):1000–1005. [PubMed: 10086434]
- Strain, EC. *Methadone dose during maintenance treatment in The Treatment of Opioid Dependence*. Baltimore, MD: Johns Hopkins Press; 2006.

Appendix A

Results from Checks for Reliability and Validity of NDATSS Data

Comparison of NDATSS Data with Data from the Drug Services Research Survey (DSRS) and the National Evaluation of Substance Abuse Treatment Study (NESAT)

A. NDATSS Comparison with Drug Services Research Survey* (DSRS)(1990)

Variable	DSRS	NDATSS
Avg. dose level/program	50 (mg/d)	46
# patients	309	306
# staff	14.5	16.3
Time in treatment	16.4	19.0

B. Comparisons of Methadone Dose Levels in the Drug Services Research Study (DSRS), the National Evaluation of Substance Abuse Treatment Study* (NESAT), and NDATSS

Variable	NESAT (1997)	NDATSS (1995, 2000)
Percent of Patients Receiving Dose Levels Below:		

B. Comparisons of Methadone Dose Levels in the Drug Services Research Study (DSRS), the National Evaluation of Substance Abuse Treatment Study* (NESAT), and NDATSS

Variable	NESAT (1997)	NDATSS (1995, 2000)	
40 mg/d	17.5	19.4	13.5
60 mg/d	42.0	50.0	35.1
80 mg/d	69.9	77.9	69.1

* DSRS: national random sample of 26 methadone treatment programs; 261 randomly-selected patient records from these programs (Batten et al., 1992)

* NESAT: National random sample of 49 methadone treatment programs (Kleber, 2000).

Table 1

Mean Scores and Standard Deviations for All Study Variables, Across All Survey Waves

	Mean (SD)
Percentage of Patients Receiving Methadone Doses:	
below 40 mg/day	23.92 (22.27)
below 60 mg/day	48.39 (28.43)
below 80 mg/day	70.55 (26.30)
Patient characteristics	
Percent unemployed	47.62 (22.77)
Percent African-American patients	27.61 (25.05)
Percent Hispanic / Latino patients	17.40 (21.95)
Percent requiring prior authorization	14.16 (28.15)
Program characteristics	
JCAHO accreditation (% yes)	29.53 (45.64)
CARF accreditation (% yes)	21.03 (40.78)
Ownership	
Private non-for-profit	51.40 (50.01)
Private for-profit	22.30 (41.58)
Public	26.40 (44.11)
Region	
Midwest	16.59 (37.22)
Northeast	37.15 (48.35)
South	25.47 (43.59)
West	20.79 (40.61)
Total patients	377.69 (537.84)
Percent staff who are ex-addicts	32.12 (46.72)
Managerial attitudes*	
Supervisor supports AA effectiveness	3.57 (1.33)
Director Supports Needle Exchanges	2.90 (1.85)
Director supports information to IDU regarding HIV prevention	4.52 (0.57)
Limited staff dedicated to HIV prevention	32.12 (46.72)

N=864

Source: National Drug Abuse Treatment System Survey (NDATSS)

Abbreviations: CARF, Committee for Accreditation of Rehabilitation Facilities; JCAHO, Joint Commission for the Accreditation of Health Care Organizations; AA, Alcoholics Anonymous; IDU, injection drug users

* These variables are measured on a 5-point Likert scale: 1=no extent and 5=very great extent

Table 2

Mean Percentage of US Patients below Methadone Maintenance Doses of <40, 60 and 80 Mg/d, 1988–2011

Year	Patients Receiving <40 mg/d, %	Patients Receiving <60 mg/d, %	Patients Receiving <80 mg/d, %
1988	44.8	79.5	94.2
1990	36.9	70.5	88.6
1995	19.2	55.5	80.6
2000	13.2	34.5	67.6
2005	16.8	34.4	57.2
2011	10.4	22.8	40.7

Source: National Drug Abuse Treatment System Survey (NDATSS)

Table 3

Results from Random Effects Regression Models of Average Program Methadone Dose Levels (N=864)

	% of Patients below 40 mg/day			% of Patients below 60 mg/day			% of Patients below 80 mg/day		
	β (SEM)	P value		β (SEM)	P value		β (SEM)	P value	
Time Trends									
1988	27.38 (4.21)	***		44.57 (4.22)	***		36.85 (3.71)	***	
1990	21.61 (2.97)	***		40.83 (3.36)	***		38.47 (2.97)	***	
1995	6.14 (2.29)	**		23.68 (3.19)	***		29.38 (2.95)	***	
2000	0.64 (1.77)			7.98 (2.36)	**		18.02 (2.62)	***	
2005	0.95 (1.56)			2.38 (2)			5.45 (2.42)	*	
2011	Ref			Ref			Ref		
Patient Characteristics									
Percent unemployed	0 (0.04)			-0.02 (0.03)			-0.07 (0.03)	*	
Percent African-American patients	0.14 (0.04)	***		0.24 (0.04)	***		0.27 (0.03)	***	
Percent Hispanic / Latino patients	0.09 (0.04)	*		0.11 (0.04)	**		0.12 (0.03)	**	
Percent requiring prior authorization	0.01 (0.02)			0.03 (0.02)			0.01 (0.02)		
Percent age 40 or above	-0.07 (0.04)			-0.11 (0.04)	**		-0.1 (0.04)	**	
JCAHO accreditation	-3.08 (1.83)			-2.78 (1.92)			-3.51 (1.75)	*	
CARE Accreditation	-2.78 (1.77)			0.46 (2.22)			-0.65 (2.37)		
Ownership									
Private non-for-profit	1.59 (1.75)			0.61 (1.85)			-1 (1.71)		
Private for-profit	1.85 (1.88)			1.62 (2.21)			-2.01 (2.4)		

	% of Patients below 40 mg/day		% of Patients below 60 mg/day		% of Patients below 80 mg/day	
	β (SEM)	P value	β (SEM)	P value	β (SEM)	P value
Public	Ref		Ref		Ref	
Region						
Midwest	6.19 (2.18)	**	3.09 (2.32)		0.24 (2.38)	
Northeast	Ref		Ref		Ref	
South	4.54 (2.25)	*	0.99 (2.25)		-2.08 (2.18)	
West	-0.06 (1.96)		0.73 (2.2)		2.62 (2.16)	
Total patients	0 (0)		0 (0)		0 (0)	
Percent staff who are ex-addicts	-0.06 (0.04)		-0.04 (0.05)		0.02 (0.05)	
Managerial Attitudes						
Supervisor supports AA effectiveness	0.55 (0.45)		0.41 (0.5)		0.03 (0.54)	
Director supports syringe exchanges	-0.65 (0.59)		-1.25 (0.66)		-1.4 (0.65)	*
Director supports information to IDU regarding HIV prevention	0.13 (1.21)		-1.94 (1.22)		-0.74 (1.18)	
Limited staff dedicated to HIV prevention	1.52 (1.4)		2.14 (1.42)		1.91 (1.41)	

Source: National Drug Abuse Treatment System Survey (NDATSS)

Abbreviations: CARF, Committee for Accreditation of Rehabilitation Facilities; JCAHO, Joint Commission for the Accreditation of Health Care Organizations; AA, Alcoholics Anonymous

Interpretation of coefficients: negative signs for a coefficient indicate that a predictor variable is associated with higher probability of a program's provision of higher methadone dose levels (e.g., JCAHO accredited programs are more likely to provide doses > 80 mg/d); positive signs indicate the reverse (e.g., programs with higher percentages of African-Americans are more likely to provide lower doses).

* p<.05;

** p<.01;

*** p<.001