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ORIGINAL ARTICLE

Outcome predictors for patients receiving methadone maintenance treatment: findings from a retrospective multi-site study

Steven L. Proctor[1], Amy L. Copeland[2], Albert M. Kopak[3], Norman G. Hoffmann[4], Philip L. Herschman[5], and Nadiya Polukhina[5]

[1]Department of Psychology, Albizu University–Miami Campus, Miami, FL, USA; [2]Department of Psychology, Louisiana State University, Baton Rouge, LA, USA; [3]Department of Criminology and Criminal Justice, Western Carolina University, Cullowhee, NC; [4]Department of Psychology, Western Carolina University, Cullowhee, NC, USA; and [5]CRC Health Group, Inc., Cupertino, CA, USA

Abstract

This study sought to determine whether select pre-treatment demographic and in-treatment clinical variables are associated with urinalysis drug screen (UDS) findings for opioids among patients receiving methadone maintenance treatment (MMT). Data were abstracted from electronic medical records for 2,410 patients admitted to 26 MMT programs from 2009–2011. Patients were studied through retrospective chart review for 12 months. UDS findings for opioids at 3-, 6-, 9-, and 12-month intervals were the outcome variables. Clinical variables included average daily methadone dosage and UDS findings for cocaine, amphetamines, cannabinoids, and benzodiazepines at intake and the various 3-month intervals. UDS+ for cocaine at intake and 3 months were found to be independent predictors of a UDS+ for opioids at 9 months. UDS+ for amphetamines and cannabinoids were found to predict UDS+ for opioids at various intervals. Higher daily methadone dosage was found to predict opioid abstinence at 9 months. Significant demographic predictors of UDS+ for opioids at various intervals included older age, unemployment, Hispanic ethnicity, and being male, single, separated, or non-self-pay. Overall, few of the demographic and clinical variables appear to provide a basis for a priori judgment about whether or not a patient presenting for MMT is likely to have a favorable long-term outcome. However, the findings do suffice to assist in making systematic improvements in MMT planning and in identifying particular subgroups of patients at risk for poor treatment response early on in the MMT process.

Keywords

Illicit drugs, methadone maintenance, opioids, outcome, predictors, treatment

History

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According to estimates from the 2010 National Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration [SAMHSA], 2011), opioids, including prescription pain relievers and heroin, had the second highest rate of past year drug dependence or abuse, behind only cannabis. Opioid use and opioid use disorders have also been associated with a variety of negative outcomes including hospitalization, economic burden, increased vulnerability to other serious medical conditions or infections, additional substance use and psychiatric comorbidity, cognitive impairment, and mortality (Brooner, King, Kidorf, Schmidt, & Bigelow, 1997; Fals-Stewart, 1997; Hulse et al., 1999; Mark et al., 2001; Pilowsky et al., 2011; Strain, 2002). Considering the range of impairment and adverse consequences associated with opioid use and opioid use disorders, effective treatment placement and completion remains an important goal.

One viable option for the treatment of opioid dependence appears to be methadone maintenance treatment (MMT), which is the most widely used form of opioid treatment in the U.S. (Parrino, 2002). MMT involves daily oral administration of a prescribed dosage of methadone under direct supervision in a government-licensed clinic and is typically monitored and controlled on a routine basis in which patients have a set schedule of attendance. Funding mechanisms for MMT in the U.S. vary by the individual facility and state in which it is located, but can include support from a combination of public sources (e.g., federal block grant, state block grant match, Medicaid, other county or local funding), private sources (e.g., managed care companies, directly by employers), or patient self-pay (SAMHSA, 2014, 2015). Financing MMT is also dependent on a number of patient and program level factors, including the patient's income level and insurance status, as well as the program's profit vs. not-for-profit status.

The efficacy of MMT in reducing illicit opioid is well-documented (for reviews see Amato et al., 2005; Marsch, 1998). Considerable research has also demonstrated a number of additional favorable outcomes associated with MMT beyond abstinence from opioids, including reduced rates of mortality, injection drug use, criminal behavior, HIV risk behaviors (e.g., needle-sharing, unsafe sexual behaviors), and HIV seroconversion (Ball et al., 1988; Bell et al., 1992; Bukten et al., 2012; Ghodse et al., 2003; Gibson et al., 2008; Hartel & Schoenbaum, 1998; Haynes et al., 2012; Hulse

Correspondence: Steven L. Proctor, Department of Psychology, Albizu University–Miami Campus, 2173 NW 99 Avenue, Miami, FL 33172, USA. E-mail: sproctor@albizu.edu

et al., 1999; Marsch, 1998; Sorensen & Copeland, 2000; Zanis & Woody, 1998). Thus, identification of various pre-treatment demographic and clinical variables that may influence MMT response (e.g., abstinence from opioids) remains of paramount importance if opioid-dependent patients, treatment providers, and society in general aspire to more favorable outcomes.

Several pre-treatment demographic and individual difference variables have been found related to various MMT outcomes (Abramsohn et al., 2009; Alterman et al., 1998; Avants et al., 1999; Gerra et al., 2004; Goehl et al., 1993; Simpson et al., 1997). For instance, method of payment for MMT services has been found to result in differential outcome expectations, particularly with respect to treatment retention (Maddux et al., 1994; Murphy & Rosenbaum, 1988). Patient fees have also been considered to be one of the major barriers to MMT (Anglin, Speckart, Booth, & Ryan, 1989; Muhleisen et al., 2005) and the inability to fund one's own treatment services has been associated with an increased delay to MMT admission (Gryczynski et al., 2011). Therefore, consideration of patients' method of payment as a pre-treatment variable appears to be a requisite for future research efforts aimed at identifying patients at risk for poor MMT response.

Additional pre-treatment demographic variables including younger age, African American race, and unemployment have all been found to significantly predict positive opioid drug screen results at 18 months following admission to MMT (Saxon et al., 1996). Greater criminal justice involvement prior to treatment admission, heavier alcohol use before or during treatment, and membership to an ethnic-minority group have also been found to correlate with various adverse MMT outcomes, including a failure to maintain abstinence from opioids (Judson & Goldstein, 1982). However, among even the strongest correlations, the correlation coefficients were relatively weak (i.e., r's $< .26$). Furthermore, gender, marital status, education, income, and employment status have all been found to relate to negative MMT outcomes (Del Rio et al., 1997; Heinz et al., 2009; Iguchi & Stitzer, 1991; Joe et al., 1990; Schottenfeld et al., 1998; Simpson et al., 1997; Szapocznik & Ladner, 1977).

Conversely, one study investigating relationships of opioid relapse rates with various patient characteristics at MMT entry, including age, gender, ethnicity, marital status, and years of education found none of the demographic variables to be a significant predictor of relapse rate to opioid use when each predictor variable was analyzed separately (Joe et al., 1994). Further, another prior study failed to identify a single demographic variable (i.e., age, gender, marital status, education, and employment status) that significantly correlated with MMT success, defined as urine samples negative for opioids at 12 months (Lehmann et al., 1993). In light of these disparate findings, additional research is warranted. Early identification of patients at elevated risk for poor treatment response, with respect to a failure to maintain opioid abstinence, has the potential to facilitate the development of intensive treatments targeted to their needs. Unfortunately, few robust predictors of treatment outcome have been identified.

Another important topic of discussion relates to the appropriate daily methadone dosage indicated for opioid-dependent patients receiving MMT past the initial induction phase. According to some researchers, lower dosages in the range of 30–60 mg/d are as effective as higher dosages in the prevention of withdrawal and relapse, particularly among heroin users (Wolff & Hay, 1994, 1995). More recent evidence suggests that as many as 40.0% of patients may maintain heroin abstinence on less than 60 mg/d (Trafton et al., 2006). Findings from numerous randomized trials, however, have demonstrated that opioid-dependent patients prescribed higher dosages of methadone tend to experience greater reductions in heroin use (e.g., Maxwell & Shinderman, 1999; Strain et al., 1993).

In fact, accumulating evidence suggests that methadone dosages between 80–100 mg/d are more effective than dosages in the range of 60–80 mg/d in retaining patients and reducing illicit drug use (Faggiano et al., 2003; Leavitt et al., 2000; Maremmani et al., 2003; Strain et al., 1999; Torrens et al., 1996). Methadone dosages greater than or equal to 100 mg/d have also been reported to result in favorable treatment outcomes with regard to maintenance of opioid abstinence (Peles et al., 2008). These findings are in line with the guidelines for the psychosocially assisted pharmacological treatment of opioid dependence and dosage practices proposed by the World Health Organization (WHO, 2009), which recommended a minimum dosage level of 60 mg be given daily to achieve abstinence from opioids. Still, WHO methadone dosing guidelines may not apply to all patients given that the range of effective methadone dosages in the treatment of opioid dependence is broad (Trafton et al., 2006). Thus, although dosages in the 60+ mg/d range appear indicated, methadone dosage guidelines, practices, and outcomes vary and warrant further investigation.

In sum, most studies investigating predictors of opioid abstinence among patients presenting for MMT have failed to identify variables that reliably predict outcomes and have included relatively small samples and/or brief follow-up periods. The limitation pertaining to sample size is particularly salient given small sample sizes have the potential to result in marginally significant effect sizes and may have an additional impact when there is multicollinearity among predictor variables. Further, many of the estimates relating to various identified predictors of outcome have been imprecise and tend to account for only a fraction of the variance. Additional work is also warranted to confirm the appropriate dosage of methadone indicated for favorable treatment response. Given these issues, the present study sought to both replicate and fill the apparent gaps in the MMT research literature using data from a large, multi-site MMT population.

The present retrospective longitudinal study has two aims. The first is to identify significant variables associated with poor treatment response at 3, 6, 9, and 12 months. The second is to replicate prior work in an effort to better delineate the average daily methadone dose most prudent for favorable treatment response at 6, 9, and 12 months. Finally, it is important to note that poor treatment response, as it is defined in the context of the present investigation, refers to a positive urinalysis drug screen (UDS) for opioids at the specified 3-month intervals through the 12-month observational period. While not without its limitations, such a definition appears to represent a reasonable balance between alternative conceptualizations of treatment response (e.g., opioid use disorder

remission, abstinence from all substance use including non-opioid illicit drugs), and is considered by many researchers to be the gold standard of measuring MMT success (Faggiano et al., 2003; Lehmann et al., 1993; Newman, 1987; Strain et al., 1999). Therefore, consistent with the research literature and the standard outcome variables commonly assessed in MMT evaluation research, UDS findings for opioids will be used as the primary indicator of treatment response.

Method

Demographic and clinical data for the present study were derived from patient records utilizing the management information system of a large U.S. health care provider. A total of 9,212 active and discharged patients admitted to a CRC Health Group-operated substance use treatment program during the period of January 1, 2009 through April 30, 2011 were initially identified based on the following specified inclusionary criteria: (1) minimum length of stay of 15 days, (2) presented for medication-assisted maintenance treatment, and (3) received methadone (as opposed to one of two buprenorphine formulations). However, only those patients for whom complete demographic data were available (i.e., gender, race/ethnicity, employment status, age, and marital status) were included in the final dataset. The largest proportion of cases were excluded due to missing employment status data (n = 5,408), followed by cases with missing marital status data (n = 1,375). In addition, one transgendered patient was excluded. Further, to define reliable measures using aggregated patient data, we followed the recommendation of Simpson et al. (1997), and excluded treatment programs for whom relatively small patient sample sizes were found (i.e., only programs including 50 or more patients were selected); which resulted in a net sample of 2,410 patients. The final sample was comprised of all patients admitted to 26 inpatient treatment facilities located throughout the U.S. (e.g., California, Oregon, Virginia, Louisiana, West Virginia, North Carolina, Kansas) during the aforementioned observational period. Given that the 26 treatment programs utilized in the present study were operated by the same national health care provider, all facilities followed similar MMT practices as outlined in a common Policy and Procedure manual. Patients were studied through retrospective electronic chart review for 12 months or until treatment discharge; whichever came first. Release of the de-identified dataset was approved by the CRC Health Group, Inc. Institutional Review Board for use in secondary analyses.

Participants

Demographic characteristics for the total sample are detailed in Table 1. The total sample was comprised of 2,410 patients (59.6% male) with an average age of 34.5 years (SD = 10.77) and a range of 18 to 82 years; although 43.0% were between the ages of 25 and 34 years. Racial composition was predominately Caucasian (80.9%) and Hispanics constituted the largest ethnic-minority group (13.1%). Nearly half (49.0%) were single at the time of intake and 31.7% indicated that they were either married or had a "significant other." Slightly more than half (52.1%) were unemployed, and 42.3% were employed at the time of intake. Regarding payment method for MMT services, 74.0% of the sample were classified as self-pay.

Table 1. Demographic characteristics for the total sample.

Variable	Prevalence % (n)
Age (years)	
18–24	17.3 (416)
25–34	43.0 (1,036)
35–44	20.1 (485)
45+	19.6 (473)
Gender	
Male	59.6 (1,436)
Female	40.4 (974)
Race/Ethnicity	
Caucasian	80.9 (1,950)
Hispanic	13.1 (315)
African American	3.1 (74)
American Indian	1.1 (26)
Asian	1.1 (27)
Other	0.7 (18)
Marital Status	
Single	49.0 (1,180)
Married/Significant Other	31.6 (763)
Separated	11.8 (285)
Divorced	5.9 (142)
Widowed	1.7 (40)
Employment Status	
Unemployed	52.1 (1,256)
Employed	42.4 (1,021)
Disabled	3.9 (95)
Student	1.0 (24)
Other	0.6 (14)
Payment Plan	
Self-pay	74.0 (1,784)
Government	12.9 (310)
Private Insurance	11.0 (265)
Other	2.1 (51)

Measures

UDS testing was conducted at the discretion of the various MMT facilities for individual treatment planning purposes or, in some cases, as a mandate in partial fulfillment of the terms of a patient's parole. Thus, testing was performed at various intervals, defined by both the state and type of patient, and the timing and frequency of testing varied across sites. However, standard procedures at all facilities required that a minimum of eight UDS tests be conducted per year for each patient. In fact, despite the variability in UDS testing procedures across sites, the frequency of UDS testing for opioids was quite consistent in that more than 99.1% of patients received a UDS for opioids at each of the various 3-month intervals through the 12-month observational period. Similarly, nearly all (99.4%) patients received a UDS for the various non-opioid substance categories at each 3-month interval, with the exception of cannabinoids. However, even UDS testing for cannabinoids was performed, on average, 84.5% of the time at the various intervals across MMT sites. The methadone dispensing software utilized by all of the MMT facilities identified patients due for a UDS on a specific day on a random interval schedule and the dispensing of an

individual patient's prescribed methadone dosage was contingent on UDS submission. Collection of specimens was observed via non-recording camera observation in accordance with each respective facility's state requirements to ensure authenticity. The type of testing performed and the panel chosen was dictated by the state's requirements, the certification of the program, and the compliance requirements of the individual facility. Specimens were subjected to an initial Immunoassay screen to assess for recent use of methadone, alcohol, amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, heroin, and oxycodone. Immunoassay class results for opioids at 3-month intervals over the 12-month observational period were utilized as the dependent variables, for the present study's analyses.

Data analyses

All UDS findings (i.e., obtained at intake, 3, 6, 9, and 12 months) were dichotomized to indicate the detection of the presence or absence of the various substances for which a UDS was administered at each respective interval. Alcohol and barbiturates were detected in less than 2.0% of cases at intake, so these substances were not considered as potential individual predictors of treatment outcomes. Similarly, all patients were positive for methadone at the 3-, 6-, 9-, and 12-month intervals, so this variable was excluded from the respective models. An outcome variable was constructed based on UDS findings for each of the specified substances at each 3-month interval through the 12-month observational period, and included all findings from which a UDS was administered within 15 days of each interval for the various substances. For example, for the 3-month cocaine UDS variable, all patients administered a UDS for cocaine between 75 and 105 days following treatment admission were included. An algorithm was also utilized to place patients into a composite "opioids" UDS category based on UDS findings for both heroin and oxycodone at the 3-, 6-, 9-, and 12-month intervals. Thus, if a patient produced a positive UDS finding for heroin, oxycodone, or both at these intervals, they received a positive UDS designation when grouped in the composite opioids UDS category.

A Pearson's chi-square test of independence was conducted to explore the relationships involving various demographic and clinical variables with the various indicators of treatment response (i.e., UDS findings for opioids at 3, 6, 9, and 12 months). In terms of racial/ethnic groups, only three groups (i.e., Caucasian, Hispanic, and African American) were of sufficient size (i.e., 50+ cases) for making statistical comparisons on indicators of treatment response. A cross-tabulation involving these three binary categorical variables was utilized to ascertain whether particular racial/ethnic groups were more strongly associated with positive UDS findings at the 3-, 6-, 9-, and 12-month intervals. However, given nearly all (91.9%) of the patients were found positive for opioids at intake, this interval was not considered in the associations involving the various demographic and clinical variables with UDS findings for opioids. A similar procedure was performed for the additional demographic variables.

A composite variable was also constructed utilizing an algorithm which summed the UDS findings for opioids obtained at each of the four 3-month intervals, yielding an outcome variable for the total number of positive UDS findings for opioids through the 12-month observational period (range 0–4). The relationships involving the various demographic and clinical variables (i.e., non-opioid UDS findings related to cocaine, amphetamines, benzodiazepines, and cannabinoids) obtained at intake with the composite outcome variable were investigated using Pearson product-moment correlation coefficients.

In addition, separate hierarchical binary logistic regression models were fitted to the data to test the hypotheses regarding whether study outcomes could be predicted by various treatment performance variables (i.e., UDS findings for cocaine, amphetamines, benzodiazepines, and cannabinoids obtained at intake and the 3-, 6-, and 9-month intervals) after adjustment for relevant demographic variables and average daily methadone dosage. Inclusion of relevant demographic variables in the various models was determined based on significant findings from the chi-square analyses. Goodness-of-fit statistics were examined to assess the fit of each respective logistic model against actual outcome (i.e., whether patients produced positive UDS findings for opioids at 3, 6, 9, and 12 months). One inferential test (i.e., Hosmer–Lemeshow) and two additional descriptive measures of goodness-of-fit (i.e., R^2 indices defined by Cox & Snell and Nagelkerke) were utilized to determine whether the various models fit to the data well. Separate binary logistic regressions were also conducted to delineate the average daily methadone dosage most prudent for achieving opioid abstinence at 6, 9, and 12 months.

Results

UDS findings

Based on UDS findings at intake, 91.9% of the patients produced a positive finding for opioids; however, 2.8% of the patients found negative for opioids at intake were administered a UDS from only one of the various opioid categories. The remaining positive UDS findings obtained at intake that predominated were as follows: benzodiazepines, 26.4%; cannabinoids, 20.7%; cocaine, 10.8%; and amphetamines, 9.1%. Examination of the UDS findings at 12 months revealed that only 10.2% of the patients produced a positive finding for opioids. Regarding the remaining UDS results at 12 months, 13.2% were positive for benzodiazepines, 10.6% for cannabinoids, 4.9% for cocaine, and 5.2% for amphetamines. Finally, a total of 463 patients were administered a UDS for opioids at all four of the follow-up intervals (i.e., 3, 6, 9, and 12 months). Findings revealed that 70.4% produced a negative finding for opioids at all four of the follow-up intervals, compared to 16.4% at three intervals, 6.9% at two, 2.8% at one, and only 3.5% produced a positive finding for opioids at all four of the follow-up intervals.

Associations between demographic variables and opioid UDS findings

Race/Ethnicity. The prevalence rates of positive UDS findings for opioids were examined by racial/ethnic groups to determine whether some demographic characteristics were

Table 2. Associations between demographic variables and positive UDS findings for opioids.

	Opioid UDS+ (%)			
Variable[a]	3-month	6-month	9-month	12-month
Race/Ethnicity				
Caucasian	21.1***	14.5**	11.4*	9.3*
African American	21.3	13.9	20.7	14.3
Hispanic	43.4***	27.0**	23.6**	17.9
Marital Status				
Married/Significant Other	19.1**	14.0	11.1	7.9
Single	27.3**	17.5	11.7	12.3
Divorced	11.6**	6.5*	10.3	5.2
Separated	25.7	18.7	18.5*	14.4
Employment Status				
Employed	20.3*	14.6	9.9*	8.1
Unemployed	27.9***	17.6	15.0*	13.2*
Disabled	5.2***	0.0*	16.7	6.7
Gender				
Male	27.6***	19.1***	15.3**	10.1
Female	17.7	11.4	9.2	10.4
Age				
35+ years	27.3**	18.0	16.3**	12.9*
Younger than 35 years	20.9	14.1	9.7	8.4
Payment Method				
Self-pay	20.6***	13.5**	11.1*	8.0**
Non Self-pay	30.9	21.1	16.1	16.2

Note. The "Opioid UDS+" category included UDS findings positive for heroin or oxycodone. UDS = Urinalysis Drug Screen.
[a] Only those demographic groups of sufficient sample size to make statistical comparisons were included.
*$p < .05$, **$p < .01$, ***$p < .001$.

more strongly associated with positive UDS findings for opioids at the various 3-month intervals than others (Table 2). Of particular interest was the significant association found between Hispanic ethnicity and more positive UDS findings at the 3-month interval [X^2 (1, N = 1,435) = 35.776, $p < .001$, φ = .158], such that 43.4% of Hispanic patients produced a positive UDS finding for opioids at 3 months, compared to only 21.2% of non-Hispanic patients. Hispanic ethnicity was also significantly associated with more positive UDS findings for opioids at the 6-month [X^2 (1, N = 1,065) = 9.355, $p < .01$, φ = .094] and 9-month intervals [X^2 (1, N = 830) = 6.629, $p < .01$, φ = .089]. Although the prevalence of a positive UDS finding for opioids for patients of Hispanic ethnicity (17.9%) was higher than that for non-Hispanic patients (9.8%) at 12 months, there was not a significant association [X^2 (1, N = 714) = 2.682, $p > .05$, φ = .061]. There was also a weak, positive correlation found between ethnicity and the composite outcome variable (r = .125, $p < .01$), with Hispanic ethnicity associated with a greater total number of positive UDS findings for opioids through the 12-month observational period.

A significant association was also found between Caucasian race and fewer positive UDS findings for opioids at the 3-month interval [X^2 (1, N = 1,435) = 23.268, $p < .001$, φ = −.127], such that only 21.1% of Caucasian patients produced a positive UDS for opioids at 3 months, compared to 35.8% of non-Caucasian patients. Caucasians were also found to produce significantly fewer positive UDS findings for opioids at the 6-month [X^2 (1, N = 1,065) = 6.761, $p < .01$, φ = −.080], 9-month [X^2 (1, N = 830) = 5.747, $p < .05$, φ = −.083], and 12-month intervals [X^2 (1, N = 714) = 5.440, $p < .05$, φ = −.087]. Furthermore, Caucasian ethnicity was significantly associated with a lower total number of positive UDS findings for opioids through the 12-month observational period (r = −.149, $p < .001$).

No significant association was found between African American race and positive UDS findings for opioids at the 3-month, 6-month, 9-month, and 12-month intervals. African American race was also not significantly associated with the total number of positive UDS findings for opioids through 12 months (r = .006, $p > .05$).

Employment status. Patients who were unemployed at intake were less likely to be abstinent from opioids during most of the follow-up intervals (Table 2). Specifically, there were significant associations found between patients who reported that they were unemployed at the time of intake and more positive UDS findings for opioids at the 3-month [X^2 (1, N = 1,435) = 15.628, $p < .001$, φ = .104], 9-month [X^2 (1, N = 830) = 4.401, $p < .05$, φ = .073], and 12-month intervals [X^2 (1, N = 714) = 5.948, $p < .05$, φ = .091], such that unemployed patients evinced significantly higher prevalence of positive UDS findings at these three intervals. There was no significant association found at 6 months [X^2 (1, N = 1,065) = 2.773, $p > .05$, φ = .051].

In addition, the prevalence of a positive UDS finding for opioids was significantly lower for patients who were currently employed at both the 3-month [X^2 (1, N = 1,435) = 6.123, $p < .05$, φ = −.065] and 9-month intervals [X^2 (1, N = 830) = 4.319, $p < .05$, φ = −.072] compared to patients in the remaining employment status groups. No significant associations were found between employment and positive UDS findings for opioids at 6 and 12 months.

There were also significant associations found between patients who reported that they were currently disabled at intake and fewer positive UDS findings for opioids at the 3-month [X^2 (1, N = 1,435) = 11.279, $p < .001$, φ = −.089] and 6-month intervals [X^2 (1, N = 1,065) = 6.135, $p < .05$, φ = −.076], such that disabled patients evinced a significantly lower prevalence of positive UDS findings for opioids at both 3 and 6 months compared to those patients who were not disabled at intake. There were no significant associations found at 9 and 12 months. Finally, results from bivariate correlations revealed that none of the employment status categories (i.e., unemployed, employed, disabled) were significantly associated with the total number of positive UDS findings for opioids through the 12-month observational period.

Marital status. Regarding patients who reported that they were single at intake, the only interval for which there was a significant association relating to positive UDS findings for opioids was at 3 months [X^2 (1, N = 1, 435) = 10.026, $p < .01$, φ = .084], in that more than a quarter (27.3%) of single patients produced a positive UDS finding for opioids at 3 months, compared to only 20.2% of patients who were not single at the time of intake (Table 2). No significant associations were found at 6, 9, and 12 months.

There were significant associations found between divorced patients and fewer positive UDS findings for opioids

at the 3-month [X^2 (1, N = 1,435) = 7.157, $p < .01$, φ = −.071, V = .071] and 6-month intervals [X^2 (1, N = 1,065) = 4.241, $p < .05$, φ = −.063], such that divorced patients evidenced a significantly lower prevalence of positive UDS findings for opioids at 3 and 6 months compared to those patients who were not divorced at the time of intake. No significant associations were found at 9 and 12 months.

Regarding the associations between patients who reported that they were either married or had a "significant other" at intake and positive UDS findings for opioids, the only statistically significant finding was found at the 3-month interval [X^2 (1, N = 1, 435) = 7.558, $p < .01$, φ = −.073]. Specifically, approximately one-fifth (19.1%) of patients who were either married or indicated that they had a "significant other" at the time of intake produced a positive UDS finding for opioids at 3 months, compared to over one-fourth (25.7%) of patients who were either not married or did not report having a significant other. No statistically significant associations were found at the other intervals.

The only statistically significant association noted between patients who reported that they were currently separated at the time of intake and a higher prevalence of positive UDS findings for opioids was found at the 9-month interval [X^2 (1, N = 830) = 4.062, $p < .05$, φ = .070]. In particular, 18.5% of separated patients produced a positive UDS finding for opioids at 9 months, compared to only 11.6% of patients who were not separated. Finally, results from bivariate correlations revealed that none of the marital status categories (i.e., single, married/significant other, separated, divorced) were significantly associated with the total number of positive UDS findings for opioids through the 12-month observational period.

Gender. Male patients were less likely to be abstinent from opioids during most of the follow-up intervals (Table 2). Specifically, there were statistically significant associations found between male gender and more positive UDS findings for opioids at the 3-month [X^2 (1, N = 1,435) = 19.068, $p <$ .001, φ = .115], 6-month [X^2 (1, N = 1,065) = 11.526, $p <$ .001, φ = .104], and 9-month intervals [X^2 (1, N = 830) = 6.911, $p < .01$, φ = .091]. For instance, 27.6% of male patients produced positive UDS findings for opioids at 3 months, compared to only 17.7% of female patients. There was no statistically significant association found at 12 months. Further, there was a weak, positive correlation found between patient gender and the composite outcome variable (r = .098, $p < .05$), with male gender associated with a greater total number of positive UDS findings for opioids through 12 months.

Age. Patients aged 35 years or older were less likely to be abstinent from opioids at the 3-month [X^2 (1, N = 1,435) = 7.989, $p < .01$, φ = .075], 9-month [X^2 (1, N = 830) = 8.050, $p < .01$, φ = .098], and 12-month intervals [X^2 (1, N = 714) = 3.867, $p < .05$, φ = .074], compared to patients younger than 35 years of age. Although there was not a statistically significant association found at the 6-month interval [X^2 (1, N = 1,065) = 2.982, p = .08, φ = .053], the directionality of the relationship was the same with respect to positive opioid UDS findings for the two age groups (18.0% vs. 14.1%). There was also a weak, positive correlation found between age and the composite outcome variable, with older age (i.e., patients 35 years of age or older) associated with a greater total number of positive UDS findings for opioids through 12 months (r = .136, $p < .01$).

Payment method. The prevalence rates of positive UDS findings for opioids were examined by payment method (self-pay vs. other payment categories) to determine whether patients' method of payment for MMT services was associated with positive UDS findings for opioids at the various 3-month intervals (Table 2). Interestingly, self-pay patients were found to be more likely to be abstinent from opioids at all four of the follow-up intervals. Specifically, there were statistically significant associations found between self-pay patients and fewer positive UDS findings for opioids at the 3-month [X^2 (1, N = 1,435) = 17.398, $p < .001$, φ = −.110], 6-month [X^2 (1, N = 1,065) = 9.483, $p < .01$, φ = −.094], 9-month [X^2 (1, N = 830) = 4.007, $p < .05$, φ = −.069], and 12-month intervals [X^2 (1, N = 714) = 10.248, $p < .01$, φ = −.120]. For instance, 30.9% of patients not classified as self-pay (i.e., government assistance or private insurance) produced positive UDS findings for opioids at 3 months, compared to only 20.6% of self-pay patients. Similar findings were noted at 12 months as 16.2% of patients not classified as self-pay produced positive UDS findings for opioids, compared to only 8.0% of self-pay patients. Further, there was a weak, negative correlation found between payment method and the composite outcome variable (r = −.118, $p < .05$), with self-pay associated with a fewer total number of positive UDS findings for opioids through 12 months.

Associations between non-opioid and opioid UDS findings

Cocaine. Several associations involving positive UDS findings for cocaine at intake and 3-, 6-, 9-, and 12-months with more positive UDS findings for opioids at the various 3-month intervals were noted. There were statistically significant associations found between positive UDS findings for cocaine at intake and more positive UDS findings for opioids at the 6-month [X^2 (1, N = 1,065) = 6.624, $p < .01$, φ = .079], 9-month [X^2 (1, N = 830) = 4.959, $p < .05$, φ = .077], and 12-month intervals [X^2 (1, N = 714) = 6.167, $p < .05$, φ = .093]. Associations involving positive UDS findings for cocaine at the 3-, 6-, 9-, and 12-month intervals with more positive UDS findings for opioids at the various intervals revealed similar results. In fact, all but one of the total cross-tabulations performed were statistically significant. Of particular interest, the prevalence of positive UDS findings for opioids at both 9 and 12 months was significantly higher for patients who produced a positive finding for cocaine at 9 months, compared to patients who produced a negative finding for cocaine at 9 months (39.5% vs. 11.1%, respectively at 9 months; 46.4% vs. 9.0%, respectively at 12 months). Finally, results from bivariate correlations revealed that there was a weak, positive correlation noted between a positive UDS finding for cocaine at intake and a greater total number of positive UDS findings for opioids through the 12-month observational period (r = .102, $p < .05$).

Amphetamines. The only statistically significant associations found between a positive UDS finding for amphetamines at intake and more positive UDS findings for opioids at the various 3-month intervals included those involving both the 3-month [X^2 (1, N = 1,435) = 4.701, $p < .05$, φ = .057] and 6-month intervals [X^2 (1, N = 1,065) = 8.547, $p < .01$, φ = .090]. Specifically, the prevalence rates of positive UDS findings for opioids at these two intervals were significantly higher for patients found to be positive for amphetamines at intake compared to patients found to be negative for amphetamines at intake. However, results from bivariate correlations revealed that a positive UDS finding for amphetamines at intake was not significantly associated with the total number of positive UDS findings for opioids through 12 months (r = .070, $p > .05$). Statistically significant associations were also found between a positive UDS finding for amphetamines at 3 months and more positive UDS findings for opioids at the 3-month [X^2 (1, N = 1,434) = 26.304, $p < .001$, φ = .135] and 6-month intervals [X^2 (1, N = 910) = 6.411, $p < .05$, φ = .084]. Finally, associations involving UDS findings positive for amphetamines at both the 6- and 12-month intervals, with more positive UDS findings for opioids at each of the various intervals were all statistically significant.

Cannabinoids. There were relatively few statistically significant associations found between positive UDS findings for cannabinoids and positive UDS findings for opioids at the various 3-month intervals, compared to the other non-opioid substances. Similar to the other substances, however, a positive UDS finding for cannabinoids at 3 months was related to a higher prevalence of positive UDS findings for opioids at the 3-month [X^2 (1, N = 1,166) = 15.965, $p < .001$, φ = .117] and 6-month intervals [X^2 (1, N = 744) = 7.346, $p < .01$, φ = .097]. Further, a positive UDS finding for cannabinoids at 6 months was also related to a higher prevalence of positive UDS findings for opioids at the 6-month interval [X^2 (1, N = 896) = 9.833, $p < .01$, φ = .105], compared to patients found negative for cannabinoids at 6 months (22.6% vs. 12.2%, respectively). Finally, bivariate correlations revealed that a positive UDS finding for cannabinoids at intake was not significantly associated with the total number of positive UDS findings for opioids through 12 months (r = −.090, $p > .05$).

Benzodiazepines. Similar to cocaine and amphetamines, a positive finding for benzodiazepines at 3, 6, 9, or 12 months was related to a greater prevalence of positive UDS findings for opioids at each of these intervals. For instance, 20.4% of patients found positive for benzodiazepines at 12 months produced a positive UDS finding for opioids at 12 months [X^2 (1, N = 713) = 12.088, $p < .001$, φ = .130], compared to only 8.7% of patients found negative for benzodiazepines at 12 months. Results from bivariate correlations, however, revealed that a positive UDS finding for benzodiazepines at intake was not significantly associated with the total number of positive UDS findings for opioids through 12 months (r = −.042, $p > .05$).

Clinical predictors of positive UDS findings for opioids

Non-opioid UDS findings. Hierarchical binary logistic regressions were also fitted to the data to assess the impact of various clinical variables on the presence of a positive UDS finding for opioids at the 3-, 6-, 9-, and 12-month intervals after adjustment for relevant covariates (Table 3). At the 3-month interval, the only clinical variable entered into the model that was found to significantly predict a positive UDS finding for opioids was a positive UDS finding for cocaine at intake [Model $X^2(10)$ = 31.200, $p < .01$, R^2 = .03 (Cox & Snell), R^2 = .04 (Nagelkerke)], after controlling for age, gender, employment status, ethnicity, marital status, and average daily methadone dosage. Further, the Hosmer–Lemeshow goodness-of-fit test was insignificant [$X^2(8)$ = 10.824, $p > .05$], suggesting that the model was fit to the data well. Thus, patients found positive for cocaine at intake were 1.60 times (95% CI: 1.03–2.47) more likely to produce a positive UDS finding for opioids at 3months, compared to patients found negative for cocaine at intake.

At the 6-month interval, positive UDS findings for both cocaine and cannabinoids at the 3-month intervals were found to significantly predict a positive UDS finding for opioids at the 6-month interval [Model $X^2(11)$ = 33.146, $p < .001$, R^2 = .04 (Cox & Snell), R^2 = .08 (Nagelkerke)], after controlling for ethnicity, marital status, and average daily methadone dosage. The Hosmer–Lemeshow goodness-of-fit test was also insignificant [$X^2(8)$ = 8.813, $p > .05$]. Thus, patients found positive for cocaine at 3 months were 3.05 times (95% CI: 1.45–6.41) more likely, and patients found positive for cannabinoids at 3 months were 2.03 times (95% CI: 1.03–3.98) more likely to produce a positive UDS finding for opioids at 6 months, compared to patients found negative for cocaine and cannabinoids at 3 months, respectively. The remaining clinical variables were not found to significantly predict a positive UDS finding for opioids at 6 months.

As can be seen in Table 3, a positive UDS finding for cocaine at intake, a positive UDS finding for cocaine at the 3-month interval, and a positive UDS finding for amphetamines at the 6-month interval were the only clinical variables found to significantly predict the likelihood that a patient would produce a positive UDS finding for opioids at 9 months after controlling for age, gender, employment status, ethnicity, marital status, and average daily methadone dosage [Model X^2 (18) = 49.745, $p < .001$, R^2 = .09 (Cox & Snell), R^2 = .17 (Nagelkerke)]. The Hosmer–Lemeshow goodness-of-fit test was insignificant [X^2 (8) = 11.180, $p > .05$].

Finally, regarding significant predictors of a positive UDS finding for opioids at the 12-month interval (Table 3), a positive UDS finding for cannabinoids at 9 months was found to have an independent influence after controlling for age, ethnicity, employment status, and average daily methadone dosage. [Model X^2 (20) = 41.517, $p <$ .01, R^2 = .09 (Cox & Snell), R^2 = .19 (Nagelkerke)]. The Hosmer–Lemeshow goodness-of-fit test was insignificant [X^2 (8) = 10.397, $p > .05$]. None of the remaining clinical variables were found to significantly predict a positive UDS finding for opioids at the 12-month interval. In other words, of all the clinical variables (i.e., non-opioid UDS findings at intake and the 3-, 6-, and 9-month

Table 3. Clinical predictors of positive UDS findings for opioids.

Predictor Variable[a]	β (SE)	*Wald's* X^2	*p*	*OR*	95% *CI*	
					Lower	Upper
3 Months						
Intake Amphetamines UDS+	0.26 (0.30)	0.724	.395	1.29	0.72	2.34
Intake Benzodiazepines UDS+	0.02 (0.17)	0.009	.923	1.02	0.73	1.42
Intake Cannabinoids UDS+	0.15 (0.17)	0.779	.377	1.17	0.83	1.63
Intake Cocaine UDS+	0.47 (0.22)	4.456	.035	1.60	1.03	2.47
Constant	−2.00 (0.39)					
6 Months						
Intake Amphetamines UDS+	0.48 (0.44)	1.203	.273	1.61	0.69	3.78
Intake Benzodiazepines UDS+	−0.20 (0.27)	0.538	.463	0.82	0.49	1.39
Intake Cannabinoids UDS+	−0.52 (0.31)	2.741	.098	0.59	0.32	1.10
Intake Cocaine UDS+	0.26 (0.36)	0.493	.483	1.29	0.63	2.63
3-month Amphetamines UDS+	0.35 (0.46)	0.572	.450	1.42	0.57	3.51
3-month Benzodiazepines UDS+	0.53 (0.32)	2.720	.099	1.69	0.91	3.17
3-month Cannabinoids UDS+	0.71 (0.35)	4.198	.040	2.03	1.03	3.98
3-month Cocaine UDS+	1.11 (0.38)	8.618	.003	3.05	1.45	6.41
Constant	−1.63 (0.37)					
9 Months						
Intake Amphetamines UDS+	−0.17 (0.83)	0.042	.837	0.84	0.17	4.29
Intake Benzodiazepines UDS+	−0.22 (0.39)	0.317	.573	0.80	0.37	1.73
Intake Cannabinoids UDS+	−0.46 (0.50)	0.876	.349	0.63	0.24	1.66
Intake Cocaine UDS+	0.98 (0.48)	4.200	.040	2.67	1.04	6.82
3-month Amphetamines UDS+	−1.85 (1.17)	2.491	.114	0.16	0.02	1.56
3-month Benzodiazepines UDS+	0.04 (0.55)	0.006	.939	1.04	0.36	3.06
3-month Cannabinoids UDS+	1.02 (0.61)	2.810	.094	2.78	0.84	9.19
3-month Cocaine UDS+	1.27 (0.61)	4.369	.037	3.55	1.08	11.65
6-month Amphetamines UDS+	1.75 (0.78)	5.097	.024	5.77	1.26	26.40
6-month Benzodiazepines UDS+	0.26 (0.52)	0.253	.615	1.30	0.47	3.64
6-month Cannabinoids UDS+	−1.16 (0.66)	3.089	.079	0.31	0.09	1.14
6-month Cocaine UDS+	0.02 (0.69)	0.001	.974	1.02	0.27	3.94
Constant	−2.71 (0.79)					
12 Months						
Intake Amphetamines UDS+	−0.95 (1.42)	0.447	.504	0.39	0.02	6.24
Intake Benzodiazepines UDS+	−0.16 (0.46)	0.120	.729	0.85	0.35	2.11
Intake Cannabinoids UDS+	−1.47 (0.83)	3.179	.075	0.23	0.05	1.16
Intake Cocaine UDS+	0.57 (0.59)	0.915	.339	1.76	0.55	5.63
3-month Amphetamines UDS+	0.65 (1.38)	0.226	.634	1.92	0.13	28.51
3-month Benzodiazepines UDS+	0.02 (0.69)	0.001	.973	1.02	0.27	3.93
3-month Cannabinoids UDS+	−0.61 (0.95)	0.414	.520	0.54	0.09	3.49
3-month Cocaine UDS+	0.43 (0.84)	0.263	.608	1.54	0.30	8.02
6-month Amphetamines UDS+	1.58 (1.00)	2.505	.113	4.85	0.69	34.27
6-month Benzodiazepines UDS+	−0.12 (0.61)	0.039	.844	0.89	0.27	2.92
6-month Cannabinoids UDS+	−1.05 (0.89)	1.401	.237	0.35	0.06	2.00
6-month Cocaine UDS+	1.27 (0.85)	2.228	.136	3.57	0.67	18.99
9-month Amphetamines UDS+	−0.16 (0.93)	0.030	.862	0.85	0.14	5.21
9-month Benzodiazepines UDS+	0.86 (0.52)	2.704	.100	2.36	0.85	6.59
9-month Cannabinoids UDS+	1.65 (0.72)	5.167	.023	5.19	1.26	21.47
9-month Cocaine UDS+	0.94 (0.75)	1.579	.209	2.55	0.59	10.98
Constant	−1.21 (0.96)					

Note. CI = Confidence Interval; OR = Odds Ratio; UDS = Urinalysis Drug Screen.
[a]For all models, relevant demographic variables were entered as covariates at block 1 with all non-opioid UDS findings for the respective interval entered as predictor variables at block 2.

intervals), a positive UDS finding for cannabinoids at 9 months was the only significant and independent predictor of a positive UDS finding for opioids at 12 months. In fact, patients found positive for cannabinoids at 9 months were 5.19 times (95% CI: 1.26–21.47) more likely to produce a positive UDS finding for opioids at 12 months, compared to patients found negative for cannabinoids at 9 months.

However, it is important to note that the overall model fit and the strength of the relationship between a positive UDS finding for cannabinoids at 9 months and a positive UDS finding for opioids at 12 months was relatively weak. Thus, although statistically significant, it appears that this predictor provided relatively little contribution to study outcome (i.e., a positive UDS finding for opioids at 12 months).

Opioid UDS findings. Not surprisingly, a positive UDS finding for opioids at each of the previous 3-month intervals was found to be a significant and independent predictor of a positive UDS finding for opioids at each subsequent interval. For instance, patients found to be positive for opioids at 9 months were 8.60 times (95% CI: 3.92–18.84) more likely to produce a positive UDS finding for opioids at 12 months,

compared to patients found to be negative for opioids at 9 months. Likewise, patients found to be positive for opioids at 6 months were 2.39 times (95% CI: 1.00–5.72) more likely to produce a positive UDS finding for opioids at 12 months, and patients found to be positive for opioids at 3 months were 3.33 times (95% CI: 1.50–7.40) more likely to do the same, compared to patients found to be negative for opioids at each respective interval [Model $X^2(3) = 83.263$, $p < .001$, $R^2 = .17$ (Cox & Snell), $R^2 = .34$ (Nagelkerke), Hosmer & Lemeshow $X^2(1) = 0.313$, $p > .05$]. Further, patients found to be positive for opioids at 6 months were 5.39 times (95% CI: 2.91–9.97) more likely to produce a positive UDS finding for opioids at 9 months compared to patients found to be negative for opioids at 6 months, just as patients found to be positive for opioids at 3 months were 3.60 times (95% CI: 1.99–6.52) more likely to do the same compared to patients found to be negative for opioids at 3 months [Model $X^2(2) = 85.575$, $p < .001$, $R^2 = .13$ (Cox & Snell), $R^2 = .25$ (Nagelkerke), Hosmer & Lemeshow $X^2(1) = 0.148$, $p > .05$]. Finally, patients found to be positive for opioids at 3 months were 13.20 times (95% CI: 8.83–19.72) more likely than patients found to be negative for opioids at 3 months to produce a positive UDS finding for opioids at 6 months [Model $X^2(1) = 171.449$, $p < .001$, $R^2 = .17$ (Cox & Snell), $R^2 = .29$ (Nagelkerke)].

Average daily methadone dosage

Regarding the average daily methadone dosage prescribed for the total sample, nearly one-third (30.1%) of patients were prescribed an average dosage between 60.1 and 80.0 mg/d and nearly as many (27.1%) were prescribed an average dosage between 40.1 and 60.0 mg/d throughout the duration of treatment. The balance of the cases was as follows: 40.0 mg/d or less, 17.0%; 80.1–100.0 mg/d, 17.1%; 100.1–120.0 mg/d, 5.9%; and only 62 patients (2.6%) were prescribed an average daily dosage of 120.1 mg or greater. Interestingly, average daily methadone dosage was not associated with the total number of positive UDS findings through 12 months ($r = .023$, $p > .05$). Regarding associations between average daily methadone dosage and positive UDS findings for opioids at 6-, 9-, and 12-month intervals when dosage was dichotomized, we first compared patients prescribed an average methadone dosage of 80.1–100.0 mg/d with those of patients prescribed an average dosage of 60.1–80.0 mg/d. There were no significant associations found at 6, 9, and 12 months.

Next, we compared the prevalence of positive UDS findings for opioids at the 6-, 9-, and 12-month intervals for patients prescribed an average methadone dosage of 80.1–100.0 mg/d with those of patients prescribed an average dosage of 40.1–60.0 mg/d. The only statistically significant association evidenced was that relating to the 9-month interval [X^2 (1, $N = 372$) = 9.533, $p < .01$, $\varphi = -.160$], such that the prevalence of positive UDS findings for opioids at this interval was significantly lower for patients prescribed an average methadone dosage of 80.1–100.0 mg/d compared to patients prescribed an average methadone dosage of 40.1–60.0 mg/d (9.0% vs. 20.3%, respectively).

Finally, comparisons involving patients prescribed an average methadone dosage of 60.1–80.0 mg/d vs. patients prescribed an average dosage of 40.1–60.0 mg/d revealed that the prevalence of positive UDS findings for opioids at 9 months (12.4%) for patients prescribed an average methadone dosage of 60.1–80.0 mg/d was significantly lower than that (20.3%) of patients prescribed an average methadone dosage of 40.1–60.0 mg/d [X^2 (1, $N = 402$) = 4.292, $p < .05$, $\varphi = -.103$]. There were no significant associations found between groups at 6 and 12 months

Interestingly, results from logistic regressions revealed that the average daily methadone dosage prescribed to patients throughout the duration of their treatment, when examined as a continuous variable, was a significant predictor of opioid abstinence, but only at the 9-month interval [Model $X^2(1) = 8.085$, $p < .01$, $R^2 = .01$ (Cox & Snell), $R^2 = .02$ (Nagelkerke), Hosmer & Lemeshow $X^2 = 5.956$, $p = .65$], with higher daily dosages related to a slightly greater likelihood (OR: 1.01, 95% CI: 1.01–1.02) that patients would produce a negative UDS finding for opioids at this interval. Further examination of the range most prudent for favorable treatment response found that patients prescribed an average dosage of 60.1–120.0 mg/d were 1.98 times (95% CI: 1.27–3.11) more likely to produce a negative UDS finding for opioids at 9 months, compared to patients prescribed an average dosage of 1.0–60.0 mg/d [Model $X^2(1) = 8.440$, $p < .01$, $R^2 = .01$ (Cox & Snell), $R^2 = .02$ (Nagelkerke)], but not at 6 or 12 months. No other average daily methadone dosage group comparisons revealed significant findings at 6, 9, or 12 months; including when dosage was dichotomized at 80.0 mg/d (i.e., 60.0–80.0 vs. 80.1 vs. 100.0).

Discussion

The findings replicate and extend prior work which indicated that various pre-treatment demographic and in-treatment clinical variables were associated with MMT outcome. Unlike prior published longitudinal MMT research, however, the present study examined the impact of various demographic variables on UDS outcome at multiple intervals, rather than at a single point in time, to test whether such variables were consistently related with study outcomes throughout the initial 12 months following admission to treatment. This strategy yielded several important implications in that the present findings revealed that most of the pre-treatment demographic variables were not reliably associated with positive UDS findings throughout the observational period. In fact, of the various demographic variables examined, membership to a racial-minority group (i.e., being of non-Caucasian race), unemployment, payment method, and being older than 35 years of age were the only variables found to evidence a significant relationship with outcome at 12 months. Furthermore, these four variables were the only pre-treatment characteristics found to correlate significantly with the composite outcome variable representing a greater total number of positive UDS findings for opioids through 12 months. Thus, it appears that demographic variables may be less important as potential variables of interest in identifying patients at risk for poor treatment response after patients have been in treatment beyond a minimum interval of time.

The present study also extends prior work by utilizing a relatively large treatment sample and examining a longer timeframe, as well as controlling for relevant demographic and clinical characteristics that have the potential to impact

outcome. Consistent with previous research (Heinz et al., 2009; Iguchi & Stitzer, 1991; Judson & Goldstein, 1982; Saxon et al., 1996), age, employment status, ethnicity, marital status, and gender were all found to significantly correlate with UDS findings at various 3-month intervals. For instance, with regard to patient gender and ethnicity, our findings are in accord with prior studies which found that male patients and patients of an ethnic-minority group were more likely to experience a poor outcome with respect to a positive UDS finding for opioids at various follow-up intervals (Iguchi & Stitzer, 1991; Judson & Goldstein, 1982). The finding that men were more likely to produce a positive finding for opioids based on UDS findings at 3, 6, and 9 months compared to women in the present study may be indicative of important gender-specific differentials relating to opioid-related problem severity and MMT prognostic indicators or it may simply be an artifact of the sample composition. Given women with more severe substance use problems have been found to seek treatment less often than men, arguably due to a positive trauma history and more frequent barriers to treatment (e.g., childcare responsibilities, inadequate health insurance; Ashley, Marsden, & Brady, 2003; Hodgins et al., 1997), further investigation is warranted.

Additional demographic variables significantly associated with poor outcome at 3, 9, and 12 months included being unemployed and older than 35 years of age. Our finding that older patients were more likely to produce a positive UDS finding for opioids at these three intervals relative to younger patients was unexpected given that, historically, older patients have been found to experience more successful MMT outcomes (Ball et al., 1988; Magura et al., 1998; Saxon et al., 1996). Older patients' greater difficulty in maintaining abstinence from opioids may be indicative of a more severe course of opioid dependence due presumably to a greater number of past failed quit attempts and related negative consequences experienced in their lifetime than younger patients. That is, the cumulative negative effects of older patients' high-risk lifestyle, severity of opioid dependence, and resultant low perceived self-efficacy in abstaining from opioid use may explain the observed poor prognostic findings. Unfortunately, data concerning number of past quit attempts and MMT history were not collected.

Of particular interest, self-pay patients were found to evince significantly better outcomes at all four follow-up intervals with respect to UDS findings for opioids, compared to patients receiving government assistance for their MMT services and those who paid with private insurance. These findings are particularly salient given payment method was reliably associated with outcome throughout the duration of the observational period. That is, in contrast to the other significant pre-treatment variables found to correlate with UDS findings for opioids at various intervals, patients' method of payment for treatment services remained a significant variable associated with outcome through 12 months following MMT admission and therefore, represents an important variable to consider at the outset of MMT. However, our findings are inconsistent with previous research which demonstrated that while patient payment method resulted in differential outcomes with respect to retention, patients asked to pay a daily methadone dispensing fee did not differ from those in the no-fee condition in terms of illicit drug use (Maddux et al., 1994). Potential reasons for the divergent findings include methodological differences and most notably the particularly small sample size utilized by Maddux et al. That is, Maddux et al. relied on retrospective self-report of intravenous drug use at 12 months, and when comparisons involving UDS findings were examined, only 64 of the initial 152 patients retained at 12 months had available UDS data. In light of these limitations, patients presenting for MMT who are not classified as self-pay may require more intensive services, and the addition of motivational incentives should be incorporated into their individualized treatment plan to experience favorable outcomes comparable to those patients paying for their own treatment services. Thus, it appears that patients who fund their own treatment may be more invested in the process than patients who do not pay the out-of-pocket expenses for MMT.

Overall, similar to the associations involving the pre-treatment demographic variables and study outcome, few of the in-treatment clinical variables were found to reliably predict UDS findings for opioids through the initial 12 months of treatment. However, the findings do still provide several implications for treatment planning. For instance, a positive UDS finding for cocaine at each of the previous intervals was found to significantly predict the likelihood that a patient would be found positive for opioids at three of the four subsequent 3-month follow-up intervals. Specifically, patients found positive for cocaine at intake were nearly 3 times more likely to produce a positive finding for opioids at 9 months compared to patients found negative for cocaine at intake, and the probability of producing a positive finding for opioids at 9 months increased slightly more than that for patients found positive for cocaine at 6 months. Also noteworthy was the correlation found between a positive UDS finding for cocaine at intake and a greater total number of positive UDS findings for opioids through the 12-month observational period. From a clinical standpoint, together these findings suggest that MMT programs may be best suited to allocate time and resources toward the treatment of cocaine use problems in addition to opioid dependence. In fact, concomitant cocaine use is common among patients presenting for MMT (Chaisson et al., 1989; DeMaria et al., 2000) and the inclusion of behavioral interventions designed specifically for cocaine use into standard MMT practices has been found to positively impact cocaine use rates (Barry et al., 2009) as well as increase abstinence from opioids (Silverman et al., 1998). Thus, MMT protocols which incorporate cocaine use treatments may improve outcomes.

Average daily methadone dosage, when examined as a continuous variable, varied as a significant predictor of outcome at the three a priori follow-up intervals (i.e., 6, 9, and 12 months). In fact, average daily methadone dosage prescribed throughout the duration of treatment was found to significantly predict outcome, but only at the 9-month interval. Our failure to find a relationship at the 6-month interval, however, is consistent with prior work (Soyka et al., 2008). Consistent with Faggiano et al. (2003), similar findings were noted when average daily methadone dosage was dichotomized, in that higher dosages (60.01–120.00 mg/d) were found to be more effective than lower dosages (1.01–60.00 mg/d) in reducing

opioid use, but again at the 9-month interval only. However, in contrast to prior findings (Maremmani et al., 2003; Strain et al., 1999), no additional average daily methadone dosage group comparisons revealed significant findings at 6, 9, or 12 months; including when average daily methadone dosage was dichotomized at 80.0 mg/d (i.e., 60.0–80.0 vs. 80.1 vs. 100.0). Thus, as described elsewhere (Trafton et al., 2006), it appears that effective and ineffective methadone dosages overlap substantially, and our findings only partially support the hypothesis that higher daily dosages of methadone better diminish opioid use (Leavitt et al., 2000; Peles et al., 2008).

The findings from the present study should be considered in light of several limitations that suggest the need for additional work in the area of identifying outcome predictors of MMT. First, the present study utilized a convenience sample comprised exclusively of patients presenting for long-term methadone maintenance in the U.S. Although the total sample was drawn from a fairly representative sample of patients admitted to 26 MMT facilities, which provided for relatively large geographical coverage, some caution is warranted in generalizing the findings to MMT programs outside of the U.S. given the disparate regulatory environments and treatment philosophies that often accompany them. Second, the finding that nearly three-fourths of the sample paid for their treatment services out-of-pocket (i.e., were self-pay) and all 26 MMT programs were "for-profit," represent another potential limitation pertaining to the generalizability of the findings given estimates from several large-scale MMT studies indicate that generally less than half of patients presenting for MMT are self-pay (Banta-Green et al., 2009; Bradley et al., 1994). Although a relative strength, the present study's 12-month observational period may also be considered a limitation in some respects. That is, given patients were followed for up to 12 months or until treatment discharge, it remains unclear if specific significant demographic and clinical predictors would have sustained themselves over a longer follow-up period, or conversely in the case of non-significant findings, if they would have predicted outcome at a later point in time. Irrespective of the follow-up interval, the present study does provide valuable insight into the various demographic and clinical variables found to impact positive opioid UDS findings through the initial 12 months following MMT admission.

Another limitation concerns the breadth of clinical data included in the dataset which was utilized for the present study's analyses. That is, although the present study examined the impact of various non-opioid UDS findings obtained at various intervals as well as average daily methadone dosage on positive opioid UDS rates, additional clinical factors found to impact UDS findings, including program philosophy and ancillary services data (Saxon et al., 1996), were not included. Moreover, motivation and readiness to change, as well as perceived self-efficacy are important individual difference factors to consider in future work given their influence on illicit drug use rates among MMT patients (Li et al., 2011; Nosyk et al., 2010). Given the large variation in average daily methadone dosage, another limitation of the present study is that overall dosage-level recommendations may not provide clinical staff with sufficient information to adequately guide treatment practice. Future research should focus on identifying the most effective processes of dosage determination practices rather than simply delineating specific dosage levels most prudent for favorable treatment response. However, inclusion of average daily methadone dosage as a predictor of MMT outcome in regression models is consistent with previous research (e.g., Hallinan et al., 2006; Soyka et al., 2008). Finally, the observed findings are predictive associations and as such, causal interpretations cannot be assumed.

As the number of U.S. adults receiving treatment for opioid dependence continues to increase annually (SAMHSA, 2011), coupled with the resultant public health concern, the challenge of identifying patients in need of specialized services at the outset of treatment remains of paramount importance. Despite the relative strengths of the present study's design and the ability to predict poor MMT outcome at select 3-month intervals, perhaps the most important implication derived was our inability to reliably identify robust predictors of positive UDS findings for opioids through the 12-month observational period. In other words, the present findings are in line with prior work, including Lehmann et al. (1993), in that "...success, as evidenced by... abstinence from opiates, is difficult if not impossible to predict." Thus, it appears that very few of the pre-treatment demographic and in-treatment clinical variables provide a basis for a priori judgment about whether or not a patient presenting for MMT is likely to have a favorable long-term outcome. However, the findings do suffice to assist in making systematic improvements in MMT planning and in identifying particular subgroups of patients at risk for poor treatment response at the earlier stages of the treatment process based on specific pre-treatment demographic and in-treatment clinical characteristics. In sum, demographic risks appeared to be more important early in treatment and the use of other substances, particularly cocaine, was associated with poorer long-term outcomes.

Declaration of interest

This project was supported in part by CRC Health Group, Inc. There are no additional conflicts of interest reported by the authors.

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