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Predictors of Patient Retention in Methadone Maintenance Treatment

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This study sought to determine whether select pretreatment demographic and in-treatment clinical variables predict premature treatment discharge at 6 and 12 months among patients receiving methadone maintenance treatment (MMT). Data were abstracted from electronic medical records for 1,644 patients with an average age of 34.7 years (SD = 11.06) admitted to 26 MMT programs located throughout the United States from 2009 to 2011. Patients were studied through retrospective chart review for 12 months or until treatment discharge. Premature discharge at 6- and 12-month intervals were the dependent variables, analyzed in logistic regressions. Clinical predictor variables included average methadone dosage (mg/d) and urinalysis drug screen (UDS) findings for opioids and various nonopioid substances at intake and 6 months. Pretreatment demographic variables included gender, race/ethnicity, employment status, marital status, payment method, and age at admission. UDS findings positive (UDS+) for cocaine at intake and 6 months were found to be independent predictors of premature discharge at 12 months. UDS+ for opioids at 6 months was also an independent predictor of premature discharge at 12 months. Higher average daily methadone dosages were found to predict retention at both 6 and 12 months. Significant demographic predictors of premature discharge at 6 months included Hispanic ethnicity, unemployment, and marital status. At 12 months, male gender, younger age, and self-pay were found to predict premature discharge. Select demographic characteristics may be less important as predictors of outcome after patients have been in treatment beyond a minimum period of time, while others may become more important later on in treatment.

Keywords: maintenance treatment, methadone, predictors, opioids, illicit drug use

Opioid use and opioid use disorders remain serious public health concerns. According to estimates from the 2010 National Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration [SAMHSA], 2011), approximately 2.2 million persons aged 12 years or older in the U.S. general population met current *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM–IV*; American Psychiatric Association [APA], 1994) criteria for an opioid use disorder (i.e., dependence or abuse). Opioids, including prescription pain relievers and heroin, had the second highest rate of past year drug dependence or abuse, behind only cannabis, and rates of current opioid dependence or abuse have also increased since 2002 (SAMHSA, 2011). 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, English, Milne, & Holman, 1999; Mark, Woody, Juday, & Kleber, 2001; Pilowsky, Wu, Burchett, Blazer, & Ling, 2011; Strain, 2002; SAMHSA, 2008).

In light of the range of impairment and adverse consequences associated with opioid use and opioid use disorders, effective treatment placement and completion is an important goal. One potential treatment option is methadone maintenance treatment (MMT), which is the most widely used form of treatment for problematic opioid use in the United States (Parrino, 2002). Systematic reviews of the vast opioid use treatment literature have shown that maintenance treatment with methadone is associated with increased treatment retention, reduced opioid use, decreased craving, and improved social functioning (e.g., Bart, 2012). The efficacy of MMT in reducing illicit opioid use among opioid-

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dependent patients is well-documented (for reviews see Amato et al., 2005; Marsch, 1998). However, considerable research has also demonstrated a consistent, statistically significant relationship between MMT retention and various additional favorable outcomes beyond abstinence from opioids (Hartel & Schoenbaum, 1998; Marsch, 1998; Sorensen & Copeland, 2000). For example, not only is the mortality rate for patients receiving MMT substantially lower than that of regular opioid users in the U.S. general adult population not in treatment, but unfavorable or premature discharge from MMT is associated with increased mortality (Caplehorn, Dalton, Cluff, & Petrenas, 1994; Gibson et al., 2008; Hulse et al., 1999; Zanis & Woody, 1998). High rates of MMT attrition are problematic and warrant the need to identify patients at elevated risk for premature discharge. Thus, identification of various pretreatment demographic and clinical variables that may impact MMT retention remains of paramount importance if opioid-dependent patients, treatment providers, and society in general aspire to more favorable outcomes.

A multitude of demographic and individual difference variables have been found to negatively impact various MMT outcomes (Abramsohn, Peles, Potik, Schreiber, & Adelson, 2009; Alterman, Rutherford, Cacciola, McKay, & Boardman, 1998; Avants, Margolin, & McKee, 2000; Goehl, Nunes, Quitkin, & Hilton, 1993; Hser et al., 2011; Lehmann, Lauzon, & Amsel, 1993; Shirinbayan, Rafiey, Roshan, Narenjiha, & Farhoudian, 2010; Simpson, Joe, & Rowan-Szal, 1997; Wong & Longshore, 2008). Select demographic characteristics including male gender, membership to an ethnic-minority group, unmarried, and unemployment have all been found to negatively influence MMT retention (Ball, Lange, Myers, & Friedman, 1988; Deck & Carlson, 2005; Del Rio, Mino, & Perneger, 1997; Hser, Anglin, & Liu, 1990; Judson & Goldstein, 1982; Mancino et al., 2010; Saxon, Wells, Fleming, Jackson, & Calsyn, 1996). Method of payment for MMT services has also been found to result in differential outcome expectations (Maddux, Prihoda, & Desmond, 1994; Murphy & Rosenbaum, 1988). Specifically, patients assigned to a fee-status treatment condition (i.e., required to pay a daily methadone dispensing fee) demonstrated a significantly lower retention rate at 12 months compared with patients who paid nothing for treatment services (34% vs. 54%, respectively; Maddux et al., 1994). Patient fees have long been considered one of the major barriers to MMT (Anglin, Speckart, Booth, & Ryan, 1989; Muhleisen, Clark, Teo, & Brogan, 2005) and the inability to fund one's own treatment services has been associated with increased admission delays to outpatient MMT (Gryczynski, Schwartz, Salkever, Mitchell, & Jaffe, 2011). Thus, consideration of select pretreatment patient characteristics at treatment admission including method of payment appear to be a requisite for future research efforts aimed at identifying patients at elevated risk for poor MMT response.

One demographic variable in particular that has consistently been found to predict premature discharge from MMT is age, with younger patients evincing higher rates of attrition, for up to 2 years following MMT admission in some studies (Ball et al., 1988; Brown, Watters, Iglehart, & Aikens, 1982; Deck & Carlson, 2005; MacGowan et al. 1996; Magura, Nwakeze, & Demsky, 1998; Mancino et al., 2010; Saxon et al., 1996; Strike et al., 2005; Torrens, Castillo, & Perez-Sola, 1996). However, with the exception of age, many studies investigating pretreatment demographic predictors of premature MMT discharge have failed to identify variables that reliably predict MMT retention, presumably due to the relatively small samples and/or the brief and variable follow-up periods utilized. 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. Furthermore, many of the estimates relating to the various identified demographic predictors of MMT discharge have been imprecise and tend to account for only a fraction of the variance. In light of these disparate findings and methodological constraints, additional research is warranted.

Beyond pretreatment demographic predictor variables, several clinical variables including opioid and nonopioid substance use both prior to and during MMT, as well as average daily methadone dosage, have been found to predict MMT retention. For instance, greater opioid use history in terms of years of use prior to MMT has been found to predict retention, whereas continued use of opioids at 3 months following MMT admission has been shown to significantly predict attrition (Brown et al., 1982; Del Rio et al., 1997; MacGowan et al., 1996). Ongoing use of alcohol and cocaine following MMT admission have also been found to negatively impact retention rates (Brands et al., 2008; Brown et al., 1982; Judson & Goldstein, 1982; Magura et al., 1998; Torrens et al., 1996). Another important clinical variable relates to the type and intensity of MMT services (i.e., appropriate methadone dosage indicated for long-term retention). In fact, accumulating evidence points to the value of higher methadone dosage prescription practices, with dosages between 80 and 100 mg/d typically found to be more effective than lower dosages (e.g., in the range of 60–80 mg/d) in retaining patients (Faggiano, Vigna-Taglianti, Versino, & Lemma, 2003; Ling, Wesson, Charuvastra, & Klett, 1996; Maremmani, Pacini, Lubrano, & Lovrecic, 2003; Strain, Bigelow, Liebson, & Stitzer, 1999; Torrens et al., 1996). Methadone dosages greater than or equal to 100 mg/d have also been shown to result in favorable treatment outcomes with regard to MMT retention compared with lower dosages (Peles, Linzy, Kreek, & Adelson, 2008). Recent findings from a meta-analysis of 18 randomized controlled trials investigating the influence of different dosage ranges on MMT retention rates suggest that favorable outcomes may also be achieved with dosages greater than or equal to 60 mg/d relative to dosages less than 60 mg/d (Bao et al., 2009). Specifically, across dosing strategies (i.e., flexible vs. fixed), 60+ mg/d was associated with greater retention than dosages $<$ 60 mg/d at both 3–6 months (62.5% vs. 50.6%, respectively) and 6–12 months (57.0% vs. 42.5%, respectively). However, it is notable that approximately half of patients maintained on $<$ 60 mg/d were retained through 6 months, and nearly as many were retained in treatment through 12 months. Thus, although dosages in the 60+ mg/d range appear indicated, methadone dosage guidelines, practices, and subsequent retention rates vary and suggest the need for future work.

In sum, increasing rates of opioid use disorders coupled with a resultant public health concern warrant further investigation to determine significant predictors of MMT outcomes and identify patients at elevated risk for poor treatment response at 6 and 12 months. In general, a large number of studies have failed to identify robust pretreatment demographic and clinical predictors of MMT attrition. Studies reporting significant independent predictors of outcome, although promising, require replication in a

well-powered investigation. Furthermore, many studies have included relatively small samples and/or brief or limited follow-up periods, and some have relied on self-reported indices of illicit drug use. The limitation pertaining to sample size appears nearly universal across studies and is particularly salient given the potential to result in marginally significant effect sizes. Further, although it is widely accepted that MMT retention is a function of methadone dosage, additional work is warranted to confirm the appropriate dosage range indicated for favorable treatment response. Given these issues, the present study sought to replicate and extend previous findings in an effort to fill the apparent gaps in the MMT research literature using data from a large, multisite MMT population.

The present retrospective longitudinal study has two aims. The first is to assess the impact of select demographic and clinical variables on premature patient discharge at 6 and 12 months. We tested this by identifying significant predictors of treatment discharge after adjustment for relevant variables to determine the effects of both pretreatment demographic variables and treatment performance variables (i.e., urinalysis drug screen [UDS] findings for opioids, cocaine, amphetamines, benzodiazepines, and cannabinoids at intake and 6 months) on attrition at the two follow-up intervals (i.e., 6 and 12 months). The second aim is to replicate prior work in an effort to best delineate the average daily methadone dosage most prudent for favorable treatment response at 6 and 12 months. We tested this in two ways. First, we tested whether patient retention could be predicted by six a priori average daily methadone dosage categories (i.e., 10.1–60.0 mg, 60.1–120.0 mg, 10.1–80.0 mg, 80.1–120.0 mg, 60.1–80.0 mg, and 80.1–100.0 mg), analyzed in logistic regressions. Second, we conducted a bivariate correlation to determine the relationship between average daily methadone dosage prescribed throughout the course of treatment (when examined as a continuous variable) and length of stay (LOS) in MMT. It was hypothesized that a higher average daily methadone dosage would be associated with increased retention.

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: (a) minimum length of stay of 15 days; (b) presented for medication-assisted maintenance treatment (as opposed to temporary placement or detoxification); and (c) 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). Next, cases with missing marital status data were excluded (n = 1,375), followed by those with missing or unknown data relating to the reason for treatment discharge (n = 754). 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 1,644 patients. The final sample was comprised of all remaining patients admitted to 26 treatment programs located throughout the United States (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 programs followed similar MMT practices as outlined in a common Policy and Procedures manual.

Patients were studied through retrospective electronic chart review for 12 months or until treatment discharge; whichever came first. Our rationale for following patients through the a priori 12-month observational period is consistent with the standard timeframe generally examined in MMT retention research (e.g., Deck & Carlson, 2005; Del Rio et al., 1997; Lehmann et al., 1993). Although there remains disagreement regarding the most appropriate duration of treatment, which depends largely on both the individual patient and the specific goals of treatment, 12 months has commonly been accepted as the minimum timeframe necessary to achieve clinical benefit for most MMT patients (Moolchan & Hoffman, 1994; Simpson et al., 1997). Accordingly, this treatment goal was explicitly conveyed to all patients upon admission to the 26 MMT programs. It is important to note, however, that in select cases, patients "successfully" completed treatment prior to 12 months. In instances in which patients were able to achieve their treatment goals in a relatively short period of time, the treatment team collaboratively arrived at the decision to discharge them due to successful treatment completion. Release of the deidentified dataset was approved by the CRC Health Group, Inc. Institutional Review Board for use in secondary analyses.

Participants

Demographic and clinical characteristics for the total sample at intake are detailed in Table 1. The total sample was comprised of 1,644 patients (63.1% male) with an average age of 34.7 years (SD = 11.06) and a range of 18 to 74 years; although 40.9% were between the ages of 25 and 34 years. Racial composition was predominately Caucasian (75.0%) and Hispanics constituted the largest ethnic-minority group (18.2%). Slightly more than half (52.0%) of the patients were single at the time of admission, and 29.3% indicated that they were either married or had a "significant other." More than half (57.0%) of the patients were unemployed, and 39.1% were employed at the time of admission. Regarding payment method for MMT services, approximately three fourths (72.1%) of the sample were classified as self-pay.

Measures

UDS testing was conducted at the discretion of the various MMT programs 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

Table 1
Demographic and Clinical Characteristics at Intake

Demographic variable	Prevalence % (*n*)
Age (years)	
18–24	18.3 (301)
25–34	40.9 (672)
35–44	19.8 (325)
45+	21.0 (346)
Gender	
Male	63.1 (1,037)
Female	36.9 (607)
Race/ethnicity	
Caucasian	75.0 (1,233)
Hispanic	18.2 (300)
African American	3.5 (57)
Native American	1.2 (19)
Asian	1.1 (27)
Other	0.9 (15)
Marital status	
Single	52.0 (855)
Married/significant other	27.2 (447)
Separated	12.6 (207)
Divorced	4.4 (72)
Widowed	1.8 (29)
Employment status	
Unemployed	57.0 (937)
Employed	39.1 (642)
Disabled	3.0 (50)
Student	0.9 (14)
Retired	0.1 (1)
Payment plan	
Self-pay	72.1 (1,186)
Government	17.9 (294)
Private insurance	10.0 (164)
Intake UDS+	
Alcohol	1.2 (20)
Amphetamines	10.8 (178)
Barbiturates	1.5 (24)
Benzodiazepines	26.5 (436)
Cannabinoids	31.7 (347)
Cocaine	11.8 (194)
Opioids	93.7 (1,537)

Note. Percentages may not total 100% due to rounding. UDS+ = Positive Urinalysis Drug Screen finding.

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 99.4% of active patients received a UDS for opioids at the 6- and 12-month intervals. Similarly, nearly all (99.6%) patients received a UDS for the various nonopioid substance categories at the two follow-up intervals, with the exception of cannabinoids. However, even UDS testing for cannabinoids was performed, on average, 92.2% of the time at the various intervals across MMT sites. The methadone dispensing software utilized by all of the MMT programs 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 nonrecording camera observation in accordance with each respective program'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. Thus, upon request, 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 the various substances at intake and 6 months were utilized as the predictor variables, analyzed in logistic regressions for the present study's analyses.

Data Analyses

Patient retention in MMT was the outcome variable of interest. The term "retention," as it is presented in the context of the current investigation, is defined as the proportion of active patients at the 6- and 12-month follow-up interval. Conversely, treatment attrition (or premature treatment discharge) refers to any situation in which patients are prematurely discharged from treatment prior to the two follow-up intervals, irrespective of the specific reason, and encompasses both patient- and organizational-level factors. That is, in the instance of patients discharged due to financial constraints or against medical advice, treatment discharge may be considered a patient-level variable, while patients discharged due to administrative reasons (e.g., not participating in treatment, failure to comply with program policies) would suggest treatment discharge to be an organizational-level variable. Patients were dichotomized as either treatment successes or premature treatment discharges at the 6- and 12-month follow-up intervals based on their LOS in treatment (measured in days). Thus, patients with an LOS $>$ 179 and 364 days at the 6- and 12- month intervals, respectively, were classified as treatment successes. In an effort to avoid artificially inflating the attrition rate at 6 and 12 months, patients who successfully completed treatment or were transferred to another MMT facility (presumably to a higher level of care) prior to the two follow-up intervals were excluded and subsequently not classified as premature treatment discharges at each respective follow-up interval. This procedure revealed that 12.6% (n = 207) and 13.7% (n = 225) of the total sample completed treatment or were transferred, respectively, during the 12-month observational period. Patients discharged after 179 days due to successful treatment completion or transfer to another MMT facility, however, were still classified as treatment successes at 6 months.

All UDS findings (i.e., obtained at intake and 6 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% of cases at intake, so these substances were not considered as potential individual predictors of treatment attrition. Similarly, all patients were positive for methadone at the various intervals following MMT admission, so this variable was excluded from the respective models. A variable was constructed based on UDS findings for each of the specified substances at intake and 6 months, and included all findings from which a UDS was administered within 15 days of each interval for the various substances. For example, for the 6-month cocaine UDS variable, all patients administered a UDS for cocaine between 165 and 195 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 6-month interval. Thus, if a patient produced a positive UDS

finding for heroin, oxycodone, or both at 6 months, they received a positive UDS designation when grouped in the composite opioids UDS category. The algorithm utilized to classify patients at intake, however, included positive findings for methadone in addition to heroin or oxycodone given methadone may have been used recreationally prior to MMT admission.

Patients were grouped into six a priori, nonmutually exclusive categories based on average daily methadone dosage received throughout the duration of their treatment (i.e., 10.1–60.0 mg, 60.1–120.0 mg, 10.1–80.0 mg, 80.1–120.0 mg, 60.1–80.0 mg, and 80.1–100.0 mg). The rationale for this categorization procedure was to first examine the differential outcome expectations for patients receiving an average methadone dosage greater than 60.0 mg/d relative to those receiving 60.0 mg/d or less. Second, in an effort to isolate the specific methadone dosage range associated with increased retention in MMT, those patients receiving greater than 60.0 mg/d were divided into two groups representing those receiving greater than 80.0 mg/d (but less than 100.1 mg/d) and those receiving less than 80.1 mg/d (but still greater than 60.0 mg/d). The methadone dosage categories described here are consistent with those commonly examined in the MMT retention literature (e.g., Bao et al., 2009; Magura et al., 1998; Peles et al., 2008; Strain et al., 1999; Torrens et al., 1996).

Separate hierarchical binary logistic regression models were fitted to the data to test the hypotheses regarding whether premature MMT discharge could be predicted at the 6- and 12-month intervals by: (a) pretreatment demographic variables alone; and (b) pretreatment and in-treatment clinical performance variables (i.e., UDS findings for cocaine, amphetamines, benzodiazepines, and cannabinoids obtained at intake and the 6-month interval) after adjustment for relevant demographic variables and average daily methadone dosage received throughout the duration of treatment. The dependent variable for the logistic regressions was a binary variable coded as 1 if discharged due to various reasons (i.e., administrative, financial, or medical) or against medical advice prior to 6 or 12 months and 0 if the patient was still enrolled in MMT at the various a priori follow-up intervals (i.e., 6 and 12 months); this provided for a measure of premature treatment discharge. Logistic regressions involving average daily methadone dosage as a predictor, however, utilized a binary dependent variable indicative of MMT retention (i.e., coded as 1 = enrolled in MMT at the two a priori follow-up intervals and 0 = discharged). Inclusion of relevant demographic variables in the various models was determined based on significant findings from 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 were classified as premature treatment discharges at 6 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 [1989] and Nagelkerke [1991]) were utilized to determine whether the various models fit to the data well. Finally, a positive UDS finding for opioids at intake was not included as a predictor variable given a positive finding for this substance was nearly universal for the total sample at intake and the resultant lack of variance precluded identifying a relationship with premature treatment discharge at the 6- and 12-month interval.

Separate binary logistic regressions were also conducted to further assess the impact of various pretreatment demographic characteristics on 6- and 12-month retention rates, as well as delineate the average daily methadone dosage category most prudent for increasing retention in MMT at 6 and 12 months. In terms of racial/ethnic groups, only two groups (i.e., Caucasian and Hispanic) were of sufficient size to justify inclusion in the models as predictor variables. Thus, the total sample was dichotomized in order to classify patients based on group membership (Hispanic vs. non-Hispanic, Caucasian vs. non-Caucasian). Logistic regressions involving these two binary categorical variables were utilized to ascertain whether particular racial/ethnic groups were more strongly associated with premature MMT discharge at the 6- and 12-month intervals. A similar procedure was performed for the patient payment method, marital status, and employment status pretreatment variables.

Results

UDS Findings and Retention Rates

Based on UDS findings at intake, nearly all (93.7%) of the patients produced a positive finding for opioids (i.e., heroin, oxycodone, or methadone). The remaining positive UDS findings obtained at intake that predominated were as follows: cannabinoids, 31.7%; benzodiazepines, 26.5%; cocaine, 11.8%; and amphetamines, 10.8%. Examination of the UDS findings at 6 months revealed that only 6.9% of the patients produced a positive finding for opioids (i.e., heroin or oxycodone). Regarding the remaining UDS results at 6 months, 4.3% produced a positive UDS finding for only one nonopioid substance, and 2.5% were found positive for more than one nonopioid substance. Specifically, 4.8% were positive for benzodiazepines, 3.7% for cannabinoids, 1.9% for cocaine, and 2.5% for amphetamines.

With respect to the observed retention rates, 46.8% of patients were retained at 6 months and 20.3% were retained at 12 months. At 6 months, the percentages regarding the total number of patients classified as premature treatment discharges due to the various specific reasons for discharge were as follows: 49.1%, against medical advice; 25.7%, administrative discharge; 23.9%, financial constraints; and 1.3%, medical discharge. However, it is important to note that as discussed earlier, patients discharged due to successful treatment completion ($n = 99$) or transfer to another MMT facility prior to the 6-month interval ($n = 101$) were excluded in an effort to avoid inflation of the attrition rate. Similar to the 6-month estimates, the percentages and specific reasons for discharge regarding the total number of premature treatment discharges at 12 months were as follows: 47.1%, against medical advice; 27.1%, administrative discharge; 24.3%, financial constraints; and 1.5%, medical discharge. Over one third of patients were excluded due to successful treatment completion ($n = 108$) or transfer to another MMT program ($n = 124$) during the 6- to 12-month interval.

Demographic Variables

Results from separate logistic regressions revealed that the risk of premature MMT discharge at 6 months was significantly higher for Hispanics (OR: 1.37, 95% CI [1.03, 1.81]), Model $\chi^2(1) = 4.738$, $p < .05$, $R^2 = .01$ (Cox & Snell), $R^2 = .01$ (Nagelkerke), unemployed patients (OR: 1.26, 95% CI [1.03, 1.56]), Model

$\chi^2(1) = 4.832$, $p < .05$, $R^2 = .01$ (Cox & Snell), $R^2 = .01$ (Nagelkerke), and patients not married or having a significant other at intake (OR: 1.27, 95% CI [1.01, 1.59]), Model $\chi^2(1) = 4.143$, $p < .05$, $R^2 = .01$ (Cox & Snell), $R^2 = .01$ (Nagelkerke), not adjusting for other factors. Patient gender, Caucasian race, age, and method of payment were not found to significantly predict premature MMT discharge at 6 months. At the 12-month interval, the risk of premature discharge was significantly higher for self-pay patients (OR: 1.44, 95% CI [1.08, 1.93]), Model $\chi^2(1) = 6.029$, $p < .05$, $R^2 = .01$ (Cox & Snell), $R^2 = .01$ (Nagelkerke), male patients (OR: 1.33, 95% CI [1.01, 1.75]), Model $\chi^2(1) = 4.110$, $p < .05$, $R^2 = .01$ (Cox & Snell), $R^2 = .01$ (Nagelkerke), and patients younger than 35 years of age (OR: 1.36, 95% CI [1.04, 1.79]), Model $\chi^2(1) = 4.831$, $p < .05$, $R^2 = .01$ (Cox & Snell), $R^2 = .01$ (Nagelkerke), not adjusting for other factors. Employment status, Hispanic ethnicity, Caucasian race, and marital status were not found to significantly predict MMT attrition at 12 months.

In summary, unemployment and being Hispanic increase initial premature discharge risks while being married seems to decrease such risks. However, by the 12-month mark, younger age, male gender, and self-pay status seem to become greater factors in failure to continue in MMT during the second 6 months of treatment.

Clinical Variables

Hierarchical binary logistic regressions were also fitted to the data to assess the impact of various clinical variables on premature MMT discharge at 6 and 12 months after adjustment for relevant covariates (see Table 2). The only intake UDS finding entered into the model that was found to significantly predict premature MMT discharge at 6 months was a positive finding for cocaine, after controlling for employment status, ethnicity, marital status, and average daily methadone dosage, Model $\chi^2(8) = 211.122$, $p < .001$, $R^2 = .19$ (Cox & Snell), $R^2 = .26$ (Nagelkerke). Further, the Hosmer-Lemeshow goodness-of-fit test was insignificant, $\chi^2(8) = 8.401$, $p > .05$, suggesting that the model was fit to the data well. Specifically, patients found positive for cocaine at intake were 1.79 times (95% CI [1.18, 2.72]) more likely to be prematurely discharged at 6 months, compared with patients found negative for cocaine at intake. At the 12-month interval, the only independent clinical variables found to significantly predict MMT discharge were a positive UDS finding for cocaine at intake and a positive UDS finding for opioids at 6 months, Model $\chi^2(13) = 52.605$, $p < .001$, $R^2 = .17$ (Cox & Snell), $R^2 = .23$ (Nagelkerke), after controlling for patient gender, age, method of payment, and average daily methadone dosage. The Hosmer-Lemeshow goodness-of-fit test was also insignificant, $\chi^2(8) = 4.510$, $p > .05$. In fact, patients found positive for cocaine at intake were 3.71 times (95% CI [1.35, 10.17]) more likely, and patients found positive for opioids at 6 months were 2.13 times (95% CI [1.10, 4.12]) more likely to be prematurely discharged at 12 months, compared with patients found negative for cocaine and opioids at intake and 6 months, respectively. The remaining intake and 6-month UDS findings were not found to significantly predict MMT discharge at the 12-month interval. In other words, it appears that a positive UDS finding for cocaine at intake and a positive UDS finding for opioids at 6 months were the only clinical variables found to independently contribute to study outcome (i.e., MMT attrition at 12 months) after adjustment for relevant covariates.

Average Daily Methadone Dosage

Regarding the average daily methadone dosage prescribed for the total sample, nearly one third (32.2%) of patients were prescribed a dosage between 40.1 and 60.0 mg/d, and nearly as many (29.0%) were prescribed a dosage between 60.1 and 80.0 mg/d throughout the duration of treatment. The balance of the cases was as follows: 40.0 mg/d or less, 20.4%; 80.1–100.0 mg/d, 13.2%;

Table 2
Clinical Predictors of Premature Treatment Discharge at 6 and 12 Months

Predictor variable[a]	β (*SE*)	Wald's X^2	*p*	*OR*	95% CI	
					Lower	Upper
6-month treatment discharge						
Intake amphetamines UDS+	0.45 (0.27)	2.727	.099	1.57	0.92	2.69
Intake benzodiazepines UDS+	0.29 (0.16)	3.356	.067	1.33	0.98	1.80
Intake cannabinoids UDS+	−0.09 (0.15)	0.376	.540	0.91	0.67	1.23
Intake cocaine UDS+	0.58 (0.21)	7.600	.006	1.79	1.18	2.72
Constant	2.00 (0.25)					
12-month treatment discharge						
Intake amphetamines UDS+	0.48 (0.60)	0.630	.427	1.61	0.50	5.24
Intake benzodiazepines UDS+	0.16 (0.30)	0.296	.587	1.18	0.66	2.11
Intake cannabinoids UDS+	0.33 (0.33)	1.025	.311	1.39	0.73	2.65
Intake cocaine UDS+	1.31 (0.52)	6.486	.011	3.71	1.35	10.17
6-month amphetamines UDS+	1.07 (0.64)	2.823	.093	2.91	0.84	10.12
6-month benzodiazepines UDS+	0.17 (0.40)	0.192	.662	1.19	0.55	2.58
6-month cannabinoids UDS+	0.57 (0.42)	1.875	.171	1.78	0.78	2.64
6-month cocaine UDS+	0.24 (0.61)	0.157	.692	1.27	0.39	4.18
6-month opioids UDS+	0.76 (0.34)	5.052	.025	2.13	1.10	4.12
Constant	−0.05 (0.58)					

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

100.1–120.0 mg/d, 3.7%; and only 25 patients (1.5%) were prescribed an average daily dosage of 120.1 mg or greater.

Results from logistic regressions revealed that patients prescribed an average methadone dosage of 60.1–120.0 mg/d were 4.01 times (95% CI [3.27, 5.10]) more likely to be retained in MMT at 6 months than patients prescribed an average dosage of 10.1–60.0 mg/d, Model $\chi^2(1) = 163.539$, $p < .001$, $R^2 = .11$ (Cox & Snell), $R^2 = .15$ (Nagelkerke). At the 12-month interval, patients prescribed an average methadone dosage of 60.1–120.0 mg/d were 3.58 times (95% CI [2.66, 4.82]) more likely to be retained in MMT than patients prescribed an average dosage of 10.1–60.0 mg/d, Model $\chi^2(1) = 76.397$, $p < .001$, $R^2 = .06$ (Cox & Snell), $R^2 = .09$ (Nagelkerke). Further examination of the specific dosage range most prudent for favorable treatment response found that patients prescribed an average methadone dosage of 80.1–100.0 mg/d were 4.47 times (95% CI [2.93, 6.80]) more likely to be retained in MMT at 6 months than patients prescribed an average dosage of 60.1–80.0 mg/d, Model $\chi^2(1) = 57.621$, $p < .001$, $R^2 = .09$ (Cox & Snell), $R^2 = .12$ (Nagelkerke). Similarly, patients prescribed an average methadone dosage of 80.1–100.0 mg/d were 3.32 times (95% CI [2.23, 4.94]) more likely to be retained in MMT at 12 months than patients prescribed an average dosage of 60.1–80.0 mg/d, Model $\chi^2(1) = 35.127$, $p < .001$, $R^2 = .06$ (Cox & Snell), $R^2 = .09$ (Nagelkerke). When comparisons involved 80.1–120.0 mg/d versus 10.1–80.0 mg/d, the differences in outcome were even more pronounced, such that those in the higher methadone dosage group (i.e., 80.1–120.0 mg/d) were 7.73 times (95% CI [5.49, 10.88]) more likely to be retained in MMT at 6 months than patients in the lower methadone dosage group, Model $\chi^2(1) = 179.994$, $p < .001$, $R^2 = .12$ (Cox & Snell), $R^2 = .16$ (Nagelkerke). At 12 months, patients in the higher methadone dosage group were 6.25 (95% CI [4.57, 8.55]) times more likely to be retained in MMT than patients in the lower methadone dosage group *d*, Model $\chi^2(1) = 128.894$, $p < .001$, $R^2 = .10$ (Cox & Snell), $R^2 = .15$ (Nagelkerke). Thus, higher average daily methadone dosages were found to predict MMT retention at both 6 and 12 months. Finally, there was a moderate, positive correlation found between average daily methadone dosage prescribed throughout the course of treatment (when examined as a continuous variable) and LOS, $r = .357$, $p < .001$, with higher dosages associated with increased retention.

Discussion

The findings replicate and extend prior work which indicated that various pretreatment demographic and clinical variables were associated with MMT retention. Unlike prior published longitudinal MMT research, however, the present study utilized a substantially larger treatment sample, examined a longer timeframe, and controlled for relevant demographic and clinical characteristics that have the potential to impact outcome. This strategy yielded several important implications in that the present findings revealed that certain pretreatment demographic characteristics were associated with differential outcome expectations at both the 6- and 12-month intervals.

Demographic variables appeared to exert their influences either early, during the first 6 months of treatment, or later during the second 6 months. Membership in an ethnic-minority group (i.e., being of Hispanic ethnicity), unemployment, and not being married or having a significant other were the only significant and independent predictors of premature MMT discharge at 6 months. However, none of these variables were found to predict discharge at 12 months; presumably because these factors had already exerted their influence at the 6-month mark. In fact, examination of the observed 6-month attrition rates for these three predictor variables revealed that 59.6% of Hispanic patients, 55.8% of unemployed patients, and 54.9% of patients not married or having a significant other (i.e., single, separated, divorced, or widowed) had already been discharged from treatment prior to 6 months. Conversely, demographic variables found to predict discharge at 12 months included male gender, method of payment for treatment services (i.e., self-pay), and being younger than 35 years of age. Thus, it appears that select demographic variables may be more important early, during the initial 6 months of MMT, while others may be more important later on in the MMT process.

For instance, with regard to patient employment status and ethnicity, our findings are in accord with prior studies which found that unemployed patients and patients of an ethnic-minority group were more likely to experience a poor outcome with respect to treatment retention (Ball et al., 1988; Hser et al., 1990; Judson & Goldstein, 1982). The finding that unemployment was found to significantly predict premature MMT discharge at 6 months was not surprising given that patient fees represent a major obstacle to successful MMT outcomes (Anglin et al., 1989; Gryczynski et al., 2011; Muhleisen, Clark, Teo, & Brogan, 2005), and the risk of dropout is higher for patients with no stable source of income prior to treatment admission (Del Rio et al., 1997). Additional correlates of unemployment, beyond simply a lack of income, may explain the observed findings considering that unemployed patients often present with co-occurring issues known to impact substance use treatment outcomes (for review see Henkel, 2011). Patients in the present study may have also been unemployed due to any number of potential contributing factors (e.g., a more severe opioid use disorder, lack of transportation, lower motivation), which would undoubtedly create barriers to successfully completing MMT. Regardless of the co-occurring issues and underlying reasons for unemployment, the development of relationships with job placement agencies or the inclusion of vocational promotion and rehabilitation services for appropriate patients at the outset of MMT may be indicated if programs aspire to impact the relatively poor retention rates among unemployed patients.

Further, patients not currently married or having a significant other at treatment admission demonstrated poorer retention in MMT at 6 months. Potential reasons for the differential outcome expectations for married/significant other patients compared with members of the other marital status categories (i.e., single, divorced, widowed, and separated) include several factors found to predict MMT retention (Shirinbayan et al., 2010; Torrens et al., 1996). That is, the presence of more immediate access to a stable social network and additional support in the form of encouragement from their partner, as well as an overall increased level of perceived social support may explain the observed findings. Therefore, ethnic-minority patients, unemployed patients, and those patients not currently married or having a significant other at admission may require additional services from the staff or the consideration of alternative treatment regimens early on in the treatment process to help thwart the problem of MMT attrition.

Attention to the unique needs of these subgroups of patients has the potential to improve retention.

Although well-documented in the MMT literature (e.g., Brown et al., 1982; Deck & Carlson, 2005; Hser et al., 1990; MacGowan et al., 1996; Magura et al., 1998; Mancino et al., 2010; Saxon et al., 1996; Strike et al., 2005), the present study also replicated prior work in that younger patients were found to evince a significantly higher rate of treatment attrition at 12 months, which suggests that younger patients may be less prepared for extended treatment. This presumably may be due to younger patients' lower maturity level or less cumulative substance-related negative consequences in their lifetime relative to older patients. Additionally, the finding that the risk of premature discharge at 12 months was significantly higher for male (OR: 1.33, 95% CI [1.01, 1.75]) than female patients may be indicative of important gender-specific differentials relating to MMT prognostic indicators or it may simply be an artifact of the sample composition. Given that women with more severe substance use problems have traditionally been found to seek treatment less often than men, arguably due to a history of trauma and the presence of more barriers to treatment (e.g., childcare responsibilities, inadequate health insurance), further investigation is warranted (Ashley, Marsden, & Brady, 2003; Hodgins, El-Guebaly, & Addington, 1997).

Together, the various demographic variables found to significantly predict premature MMT discharge at both 6 and 12 months suggest that more intensive and/or supplemental services may be appropriate for select subgroups of patients. Although the predictors of treatment discharge by 12 months (i.e., $<$ 35 years of age, male, and self-pay) may not require immediate attention relative to the 6-month predictors and related constructs (e.g., unemployment, limited support), MMT programs should consider early intervention with members of these select groups if 12-month retention rates are desired. From a clinical standpoint, one potential treatment option would be to incorporate motivational enhancement techniques (e.g., motivational interviewing) into standard treatment programming (Miller & Rollnick, 1991). At the program level (and assuming local resources permit such a strategy), MMT programs may consider determining the composition of select psychotherapeutic groups on the basis of age or gender, and supplementing standard programming with topics or techniques designed to increase treatment engagement. At the individual level, both appointments with counselors or case managers and visits with prescribing physicians also represent a suitable context to elicit motivation from patients at elevated risk for premature discharge, which in turn may improve treatment outcomes.

The finding that patients' method of payment for MMT services predicted premature discharge at the 12-month interval warrants additional comment. Viewed from a sheer economical perspective, the finding that self-pay status eventually became associated with decreased retention in treatment relative to non-self-pay patients over time is hardly surprising given the cumulative out-of-pocket expenses that self-pay patients would have acquired had they remained in treatment through 12 months. The differential outcomes appear to be more an issue of the apparent inability to sustain payment for treatment services, and suggest that cost may not become a statistically significant treatment barrier to successful outcomes until self-pay patients have been in treatment beyond a minimum of 6 months. The additional finding that an estimated one in four premature MMT discharges at both the 6- and 12-month mark were discharged due to financial constraints further confirms the notion that cost may be a significant barrier to MMT completion. Thus, the observation that self-pay status comes into play after a period of being in MMT suggests that economic factors beyond employment alone may be an impediment to long-term treatment. The data are compatible with the conjecture that those for whom the costs of treatment are an economic strain may be more likely to discontinue their treatment. While the trends for employment and payment source are in the consistent direction, it may be the case that one is more important during the two time intervals.

The general finding that positive UDS results for substances other than opioids at intake are associated with increased attrition risks has implications for treatment planning. However, the most important implication concerns the fact that a positive UDS finding for cocaine at intake and 6 months were both found to independently predict premature treatment discharge, after adjustment for relevant demographic variables and additional UDS findings obtained at intake and 6 months. Specifically, patients found positive for cocaine at intake were nearly two times more likely to be discharged at 6 months and almost four times more likely to be discharged by the 12-month mark. From a clinical standpoint, these findings suggest that MMT programs should allocate time and resources toward the treatment of cocaine use and related problems in addition to opioid dependence, rather than simply focusing on the treatment of opioid-related problems alone. In fact, concomitant cocaine use is common among patients presenting for MMT (Chaisson et al., 1989; DeMaria, Sterling, & Weinstein, 2000) and the inclusion of cognitive–behavioral or reinforcement-based interventions designed specifically for cocaine use into standard MMT practices has been found to positively impact clinical outcomes (Barry, Sullivan, & Petry, 2009; Rawson et al., 2002; Silverman et al., 1998). Thus, MMT protocols which incorporate additional psychosocial approaches for cocaine use may improve patient retention in treatment.

Another key finding is the confirmation of previous work that higher dosages of methadone consistently produce better results. Our findings are consistent with previous research (Bao et al., 2009; Faggiano et al., 2003; Ling et al., 1996; Maremmani et al., 2003; Strain et al., 1999; Torrens et al., 1996) in that higher average methadone dosages were associated with increased retention in treatment. Of particular interest were the 6- and 12-month outcomes when average methadone dosage was dichotomized at 80.0 mg/d (i.e., 60.0–80.0 vs. 80.1 vs. 100.0). Specifically, results from logistic regressions revealed that there was over a fourfold increase in the likelihood of MMT retention for patients prescribed the higher dosage at 6 months, and more than three times as likely to be retained in treatment at 12 months. Therefore, the findings suggest that MMT retention appears to be a function of average daily methadone dosage and support the hypothesis that higher daily methadone dosages may positively impact retention in MMT. Although including average daily dosage as a predictor of MMT outcome in regression models is consistent with previous research, when analyses

were conducted with peak methadone dosage as a predictor, the observed findings remained generally the same.

It is important to note, however, that although there may be some pharmacological basis for the observed differential findings, the outcomes are likely to be multiply determined, and as such, require additional discussion regarding alternative interpretations. That is, there may be clinical expectancies and biases operating that are not apparent in the data but that played a role in patient retention in treatment. For instance, the findings regarding the associations between lower dosage ranges and decreased retention may be the product of less treatment engagement as opposed to simply a matter of dosage. That is, given higher dosages of methadone have the potential to attenuate or block the reinforcing effects of opioids (SAMHSA, 2005), patients may have intentionally requested lower dosages in an effort to continue using illicit opioids. Similarly, patients may have been aware of methadone's relative ease of cessation at lower dosages due to decreased withdrawal symptoms. Considering that many programs are responsive to patient requests for lower dosages, both patient and physician biases—although not apparent from patient data derived from electronic medical records—may be important sources of variance in terms of outcomes, which warrant the need for further investigation.

Study Limitations

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 predictors of MMT retention. First, the present study utilized a predominately Caucasian convenience sample comprised exclusively of patients presenting for long-term methadone maintenance in the United States. Despite the relatively large geographical coverage relating to the MMT programs utilized in the present investigation, some caution is warranted in generalizing the findings to other programs, particularly those serving populations with a more varied racial/ethnic composition. Furthermore, the finding that nearly three fourths of the sample funded their own treatment (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, Maynard, Koepsell, Wells, & Donovan, 2009; Bradley, French, & Rachal, 1994). The present study design also consisted of retrospective longitudinal electronic chart review and therefore, warrants further prospective longitudinal work.

Another limitation involved the issue of missing or incomplete demographic data for a sizable number of patients included in the initial data set. That is, in the instance of unavailable data for select demographic variables for a substantial number of patients, it is possible that more complete demographic data might have altered the results; although a larger sample size has the potential to reinforce the present findings as well. Thus, the present findings should be considered as a minimum dataset, consisting of lower bound estimates of demographic predictors of outcome within the current sample. The breadth of clinical data included in the present dataset represents another limitation. Although the present study examined the impact of various UDS findings obtained at various intervals as well as average daily methadone dosage on MMT retention, additional clinical factors found to impact retention, including program philosophy and ancillary services data, as well as extent of prior substance use and treatment admissions history data (Brown et al., 1982; Deck & Carlson, 2005; 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 MMT retention and various clinical outcomes (Hser et al., 2011; Joe, Simpson, & Broome, 1998; Li, Ding, Lai, Lin, & Luo, 2011; Nosyk et al., 2010; Wong & Longshore, 2008).

Given the large variation in average daily methadone dosage, another limitation 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 (e.g., examination of serum methadone levels; Leavitt, Shinderman, Maxwell, Eap, & Paris, 2000) rather than simply delineating specific dosage levels most prudent for favorable treatment response. However, inclusion of average daily methadone dosage as a predictor of outcome in regression models is consistent with previous MMT research (Hallinan, Ray, Byrne, Agho, & Attia, 2006; Soyka et al., 2008). Consideration of various individual difference (e.g., sexual abuse history, mental health conditions) and treatment delivery (e.g., guideline adherence, tendency to encourage dosage reductions) factors found to correlate with the dosage of methadone at which patients achieve positive clinical outcomes is also a requisite for future studies (Trafton, Minkel, & Humphreys, 2006). Finally, the observed findings are predictive associations and as such, causal interpretations cannot be assumed.

Conclusions

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 and measures to optimize positive outcomes is of paramount importance. Specific modifications to treatment regimens early on in the process for certain subgroups of patients based on select pretreatment characteristics and intake UDS findings have the potential to forestall premature treatment discharge. Despite the short-term predictive value of select factors at treatment admission, consideration of additional variables might also serve as equally important indicators to guide subsequent treatment planning beyond a minimum interval of time. In sum, the current findings provide indications that consideration of demographic and economic factors along with clinical factors, such as the use of other substances (i.e., cocaine), may provide strategies for enhancing retention in MMT. Improvements in retention are essential to reduce the occurrence of repeated treatment episodes and improve the overall clinical outcomes of these patients.

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