Intensive Case Management-based Treatment Program for Patients with Methamphetamine Use Disorder: A 12-month Follow-up Study

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Abstract

Objective: Methamphetamine use disorder (MUD) is a global public health concern. While case management programs are used for treating substance use disorders, evidence of their efficacy remains limited. In this study, we intended to compare treatment outcomes between those receiving intensive case management (ICM) and those receiving treatment-as-usual (TAU) over a 12-month period. **Methods:** This prospective follow-up study was done on patients with MUD referred from an outpatient treatment unit. Participants in the ICM group were matched with those in the TAU group in age, sex, and severity of dependence scale (SDS) scores, with a 1: 3 ratio. Outcome measurements included monthly urine screenings for methamphetamine, along with scores on the SDS, Visual Analog Scale (VAS) for craving, and Brief Symptom Rating Scale at 3, 6, and 12 months. **Results:** The study had 124 study patients, with 31 in the ICM and 93 in the TAU group. While patients in the ICM program had a shorter history of methamphetamine use, they showed more psychiatric comorbidities (depressive and anxiety disorders) and a history of suicide attempts at baseline, compared to the TAU group. Both groups showed significant more improvements in SDS ($p < 0.05$) and VAS ($p < 0.01$) scores over the 12-month period, with no between-group differences in outcomes. **Conclusion:** Despite the presence of severe psychiatric problems, the ICM group showed a similar level of improvement as the TAU group in treatment outcomes during the one-year follow-up. ICM may prove advantageous for patients with MUD, particularly those with pronounced psychiatric challenges.

Key words: psychiatric comorbidities, the five-item Brief Symptom Rating Scale, treatment outcome, Visual Analog Scale
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Introduction

Methamphetamine, a widely abused illicit drug, has remarkable health hazards worldwide [1, 2]. Methamphetamine use has been remarkably associated with various physical and psychological sequelae, including adverse effects on mental health, increased infectious disease prevalence, heightened cardiovascular disease risk, and higher mortality rates [1, 3]. The existing circumstances underscore the urgency of addressing effective interventions for patients with methamphetamine use disorder (MUD). Presently, an effective pharmacological treatment for MUD is nonexistent. Thus, there is a compeling need for the development of effective prevention and treatment strategies to address this global challenge.

As part of mental illness treatment, case management has been widely used to help improve outcomes [4]. For example, in patients with severe mental illness, case management has provided benefits in decreased hospitalization and increased treatment retention rates [5]. Regarding the treatment of addiction, case management has consistently enhanced treatment adherence [6, 7]. But literature

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examining the benefit of relapse prevention has mixed results [8]. For instance, a study done in Sweden suggested that involuntarily committed patients with substance abuse have shown remarkable improvements in maintaining substance abstinence after receiving treatment, including case management [9], while another study in the United States has shown no differences when case management was used in the treatment of substance-abusing parolees [6]. Additionally, the majority of studies examining the outcomes of case management programs have primarily focused on alcohol and cocaine use disorders [10, 11] or opioid use disorders [12, 13]. A paucity of data exists to specifically address the treatment outcomes for MUD, consequently impeding the formation of conclusive evidence about the advantages of such a program.

In 2018, the Institute of Substance Treatment and Research in Taipei (ISTART) was established to provide community-based intensive case management (ICM) for individuals with MUD. The ICM program, led by case managers, entails brief interventions, supportive psychotherapy, and urine screening for substances at least once per month [2]. Referrals to the ICM program are made based on the clinician's assessment of the patient's clinical requirements for a higher level of care or at the patient's request. But the extent to which this program contributes to relapse prevention or fosters psychological improvements, such as a reduction in craving severity and emotional distress, remains uncertain. In contemporary addiction research, these outcome measures serve as vital metrics in determining the efficacy of a treatment or intervention program [14-16].

To understand the benefit of the ICM program for individuals with MUD, we intended to do a one-year follow-up study to compare the relapse rates according to routine urine screening results, craving severity for methamphetamine use, and psychological consequences between those receiving ICM and those receiving treatment-as-usual (TAU) only. TAU only provides urine screening and a limited time for medical consultation.. Moreover, we also intended to examine factors related to relapse, which would provide insights into tailored treatment of individuals with MUD.

Methods

Study participants

The study protocol received the approval of the institutional review board at Taipei City Hospital (IRB protocol number = TCHIRB-10810018 and date of approval = March 4, 2020) with the need to obtain informed consents from the study participants. We enrolled individuals who had been charged with their initial methamphetamine drug offense and were directed by the Taiwan Taipei District Prosecutors Office to participate in a 12-month mandatory addiction treatment program at Taipei City Psychiatric Center within Taipei City Hospital.

The inclusion criteria were (a) age ≥ 18 years; (b) being satisfied *the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, criteria of the American Psychiatric Association for MUD, as verified by at least one board-certified psychiatrist; (c) methamphetamine as the main drug of abuse in the past; (d) no current involvement in any other intervention program for this offense; and (e) ability to read Chinese and having willingness to provide informed consent. All participants were informed that their study participation would not influence their legal status. All participants were recruited between January 1, 2020, and August 30, 2022.

In the study, 377 participants were included. Participants who we enrolled were divided into ICM (n = 31) and TAU (n = 346) groups depending on whether they were receiving further ICM programs. Prior studies have indicated that sex, age, and severity of methamphetamine dependence are factors associated with relapse in patients with MUD. Individual matching was used to match participants between groups at a 1: 3 ratio (ICM: TAU), with matching criteria including age, sex, and severity of methamphetamine dependence. This approach enabled meaningful comparison between the two treatment groups. A total of 31 participants in the ICM group and 93 participants in the TAU group were included in our study.

Intervention

All participants, either the ICM or TAU group, visited the outpatient clinic for addiction therapy provided by addiction psychiatrists following a predetermined schedule, comprising four weekly sessions, followed by four biweekly sessions, and then nine monthly sessions. During each session, structured treatment was provided according to a standardized protocol involving a multifaceted approach. This approach encompassed motivational interviews and psychotherapy for relapse prevention.

Participants with more complex clinical conditions were assigned to the ICM group through clinical judgment. These conditions included comorbid mood disorders, suicidal tendencies, aggression, socioeconomic disadvantages, and significant family conflicts. These conditions included that the ICM group participants received intensified case management, which involved various aspects such as telephonic consultation, supportive psychotherapy, crisis intervention, allocation of medical services, referrals to family or couple therapy when necessary, or guidance to community resources. Trained case managers with specialization in psychology or counseling performed monthly brief interventions for this group. Each intervention, lasting 15–30 minutes, encompassed motivational enhancement, bolstering self-efficacy and problem-solving skills and enhancing emotional awareness, and cognitive-behavioral therapy tailored to relapse prevention. This personalized approach is aimed at optimizing treatment benefits. Furthermore, ICM provided additional interventions, including psychotherapy, occupational therapy, and social worker involvement, through intensified case management sessions held at least monthly. Participants were considered treatment completers if they attended more than 13 sessions (about 80% of required sessions) or remained in treatment for more than 12 months.

Data collections

Clinical assessment

Trained interviewers did interviews with participants to gather data regarding their sociodemographic characteristics (e.g., age, sex, education level, employment status, and marital status), methamphetamine use patterns (e.g., age at first methamphetamine use, methamphetamine use duration, methamphetamine craving, methamphetamine dependence severity, history of polysubstance abuse, and experienced induced psychosis after methamphetamine use), alcohol consumption habits, degree of nicotine dependence, past psychiatric medical history (e.g., depressive disorder, anxiety disorder, and major psychiatric disorder), history of suicide attempts, and severity of psychological distresses. Hard copies of questionnaire were administered to the participants, and they received urine toxicology tests for methamphetamine at each session.

Craving severity for methamphetamine

Using a Visual Analog Scale (VAS), craving severity was assessed. Participants were provided with a thorough explanation by research assistants and then self-rated their craving for methamphetamine by placing a mark on a continuous line that ranged from 0 (indicating no craving) to 100 mm (representing severe craving, wherein an individual cannot resist methamphetamine if available) [17].

Methamphetamine dependence severity

In this study, methamphetamine dependence severity was assessed using the validated four-item Severity of Dependence Scale (SDS) Chinese version [18]. A score of four or higher on the SDS indicates methamphetamine dependence [19].

Psychological distress severity

Psychological distress was assessed using the Chinese version of a five-item Brief Symptom Rating Scale (BSRS-5), which has been tested and determined to be a reliable measure of psychological distress [16]. Higher scores indicate a higher level of psychological distress. This instrument demonstrated excellent internal consistency reliability with Cronbach's alpha coefficients ranging from 0.77 to 0.90 and good test–retest reliability ($r = 0.82$).

Alcohol drinking habits

The Alcohol Use Disorders Identification Test (AUDIT) was used to evaluate alcohol consumption habits. AUDIT is a 10-item screening tool developed by the World Health Organization and is an effective and reliable screening tool for detecting risky and harmful drinking patterns [20].

Level of nicotine dependence

The degree of nicotine dependence was evaluated using the validated of Fagerström Tolerance Questionnaire (FTQ). FTQ is a standard instrument for assessing the intensity of physical addiction to nicotine, the Chinese version of which has been tested and determined to be a reliable measure of the degree of nicotine dependence [21].

Outcome measurement

The study outcomes included relapse, methamphetamine craving, methamphetamine dependence severity, and psychological distress severity, and those outcomes were measured at baseline, 3, 6, and 12 months after participant enrollment. Methamphetamine relapse was defined as any positive urine toxicology result or self-report of methamphetamine use during treatment sessions. Urine testing was done weekly in month 1, biweekly in months 2–3, and monthly in months 4–12. Relapse was assessed across three time periods: 0–3 months, 4–6 months, and 7–12 months of follow-up.

Statistical analysis

To examine the differences in demographic characteristics and baseline clinical variables between the ICM and TAU groups, we used the Student's *t*-test and Chi-squared tests for continuous and categorical data, respectively.

The difference in the outcome variables was analyzed using a generalized estimating equation (GEE) to determine the efficacy of ICM programs on outcome variables. The outcome variables were adjusted for baseline scores and for demographics and comorbidities that significantly varied at baseline.

We used univariable and multivariable logistic models to investigate the factors associated with relapse (yes or no) and treatment completion (yes or no). Owing to the limited number of events related to the history of suicide attempts, this factor was excluded from the multivariable regression model for predicting relapse.

The study variables were analyzed using Statistical Analytic System software version 9.4 (SAS Institute, Cary, North Carolina, USA). The differences between the groups were considered significant if p values were < 0.05.

Results

Table 1 reveals the sociodemographic data of the 124 participants who used methamphetamine, with a male predominance (100%). Their ages ranged from 21 to 57 years, with a mean age of 36.7 years. Compared with the TUA group, participants in the ICM group tend to have a significantly shorter duration of methamphetamine use ($p < 0.05$), a significantly shorter percentage of history of suicide attempts ($p < 0.05$), and significantly more comorbid psychiatric conditions ($p < 0.01$), such as depressive and anxiety disorder. The following factors are noteworthy: the age of initiation of methamphetamine use, craving severity, percentage of positive baseline results and relapse rate, and psychological distress level did not significantly differ between the ICM and TAU groups (Table 1). Overall, about 70% of our participants completed a 12-month treatment; however, a significant difference was not found in the relapse rates between the ICM and TAU groups.

Compared to the baseline conditions, participants in the ICM or TAU groups revealed significantly lower rates of positive urine tests after four to six months (Figure 1a),

Table 1. Demographic and baseline clinical variables in intensive case management and treatment-as-usual groups among methamphetamine users (n = 124)

	ICM group, mean ± SD (n = 31)	TAU group, mean ± SD (n = 93)
Demographic-related variables		
Age, years	36. 64 ± 9.12	36.69 ± 8.85
Sex (male), n (%)	31 (100)	93 (100)
Less than and equal to high school, n (%)	12 (38.71)	50 (53.76)
Married§, n (%)	3 (9.68)	11 (11.96)
Employed, n (%)	27 (93.10)	89 (97.80)
Substance use-related variables		
Age of first methamphetamine use, years	30.12 ± 10.11	26.64 ± 9.25
SDS score	5.93 ± 2.52	5.36 ± 2.51
VAS for craving score	2.44 ± 2.83	2.26 ± 2.54
Urine test positive at baseline, n (%)	10 (32.26)	25 (26.88)
Duration of methamphetamine use, years	5.94 ± 6.13	9.58 ± 9.49*
Polysubstance use, n (%)	14 (45.16)	28 (30.11)
History of psychosis associated with methamphetamine use, n (%)	9 (31.03)	12 (14.29)
AUDIT score	2.51 ± 5.55	2.58 ± 5.43
FTQ score	2.52 ± 3.91	2.83 ± 2.89
History of psychiatric illnesses, yes, n (%)	16 (53.33)	14 (15.05)**
Depression	9 (29.03)	7 (7.53)**
Anxiety	6 (19.35)	4 (4.3)**
Severe mental illnesses§	4 (12.9)	3 (3.23)
History of suicide attempt, yes, n (%)	8 (25.18)	10 (10.75)*
BSRS score	6.35 ± 5.41	4.83 ± 4.54
Treatment completion, yes, n (%)	24 (77.42)	62 (66.67)
Relapse during the treatment period, n (%)	18 (58.06)	56 (60.22)

*$p < 0.05$; **$p < 0.01$ significantly difference between two groups using t-test or Chi-square if appropriate; §Fisher's exact test
Severe mental illnesses included schizophrenia or bipolar disorder
AUDIT, Alcohol Use Disorder Identification Test; BSRS, Brief Symptom Rating Scale; FTQ, Fagerstrom Tolerance Questionnaire; SDS, Severity of Dependence Scale; VAS, Visual Analog Scale; ICM, intensive case management; TAU, treatment as usual; SD, standard deviation

reducing methamphetamine dependence severity after six months of treatment and remaining sustained until the 12th month (Figure 1b), decreasing craving over time (Figure 1c). Also, improvement was observed in BSRS at the 12th month (Figure 1d). However, the results of the GEE model analysis on urine toxicology testing, methamphetamine dependence severity, craving severity, and psychological distress showed that there was no interaction effect (treatment group × time) between the ICM and TAU groups over time (3, 6, and 12 months) (Table 2). During the treatment periods, no statistically significant difference was found in the relapse rates between the ICM and TAU groups. The relapse rates were 58.06% and 60.06%, respectively (nonsignificantly different).

Table 2. The difference in treatment outcomes over time between intensive case management and treatment-as-usual groups was assessed by a generalized estimating equation - modeling approach

	Estimate
Urine positive rate	
ICM group (ref = TAU group)	0.096
Time (ref = 0–3 months)	
4–6 months	−0.054*
7–12 months	−0.038
Interaction effect (ref = TAU group × 0–3 months)	
ICM group × 4–6 months	−0.045
ICM group × 7–12 months	−0.053
SDS	
ICM group (ref = TAU group)	0.6386
Time (ref = baseline)	
3 months	−0.597
6 months	−1.299**
12 months	−1.155**
Interaction effect (ref = TAU group × baseline)	
ICM group × 3 months	0.617
ICM group × 6 months	1.403*
ICM group × 12 months	0.673
VAS for craving score	
ICM group (ref = TAU group)	0.120
Time (ref = baseline)	
3 months	−1.099**
6 months	−1.692**
12 months	−1.499**
Interaction effect (ref = TAU group × baseline)	
ICM group × 3 months	0.161
ICM group × 6 months	0.743
ICM group × 12 months	0.573
BSRS	
ICM group (ref = TAU group)	1.526
Time (ref = baseline)	
3 months	−0.607
6 months	−0.436
12 months	−1.178*
Interaction effect (ref = TAU group × baseline)	
ICM group × 3 months	1.536
ICM group × 6 months	0.209
ICM group × 12 months	1.028

*$p < 0.05$; **$p < 0.01$ significant difference using GEE-model analysis
BSRS, Brief Symptom Rating Scale; GEE: generalized estimating equation; ICM, Intensive Case Management; TAU, treatment as usual; SDS, Severity of Dependence Scale; VAS, Visual Analog Scale

Table 3 presents the correlations of the factors of clinical characteristics at baseline with relapse. In the multivariable logistic regression model, participants with significantly lower educational attainment (odds ratio [OR], 95% confidence interval [95% CI] = 4.04 [1.03–15.77], $p < 0.05$) and a significantly higher craving for methamphetamine (OR [95% CI] = 1.92 [1.3–2.83], $p < 0.01$) were significantly associated with relapse.

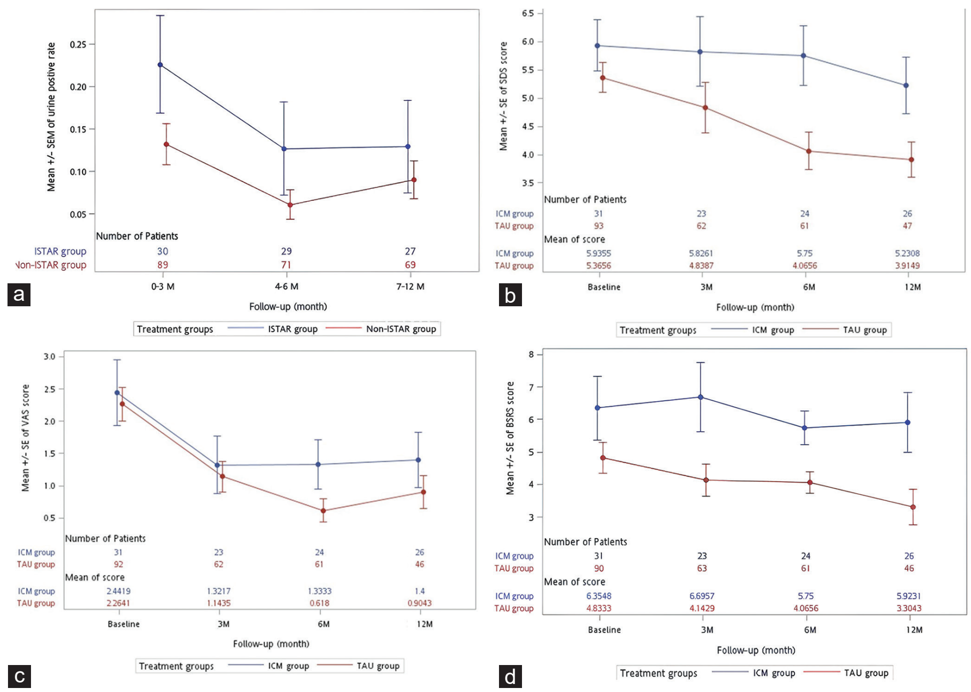

Figure 1. The comparison of treatment outcomes over time between ICM and TAU groups. (a) Rates of urine-positive results for methamphetamine; (b) SDS scores; (c) VAS scores of craving; (d) BSRS scores. BSRS, Brief Symptom Rating Scale; SDS, Severity of Dependence Scale; VAS, Visual Analogue Scale.

Table 3. Univariable and multivariable logistic regression to examine the association of relapse (dependent variable) with demographic and clinical variables (independent variables) for the entire sample ($n = 124$)

Variables	Univariable logistic regression OR (95% CI)	Multivariable logistic regression OR (95% CI)
ICM group versus TAU group	0.91 (0.4–2.09)	0.71 (0.19–2.65)
Demographic related variables		
Age (years)	1.05 (1.01–1.1)*	1.26 (0.77–2.07)
Less than and equal to high school versus higher than high school	4.06 (1.88–8.76)**	4.04 (1.03–15.77)*
Married versus other	0.37 (0.09–1.38)	1.06 (0.19–5.84)
Substance use-related variables		
Age of first methamphetamine use (years)	0.97 (0.93–1.01)	0.81 (0.49–1.32)
SDS score	1.19 (1.02–1.38)*	1.11 (0.87–1.42)
VAS for craving score	1.46 (1.21–1.76)**	1.92 (1.3–2.83)**
Duration of methamphetamine use (years)	1.12 (1.05–1.19)**	0.86 (0.52–1.41)
Urine test positive at baseline (yes vs. no)	19.31 (4.37–85.38)**	-
Polysubstance use (yes vs. no)	1.31 (0.6–2.78)	0.88 (0.03–1.79)
History of psychosis associated with methamphetamine use (yes vs. no)	1.35 (0.5–3.65)	0.56 (0.08–3.92)
AUDIT score	0.98 (0.92–1.05)	0.90 (0.78–1.03)
FTQ score	1.02 (0.91–1.15)	0.92 (0.76–1.11)
History of suicide attempt (yes vs. no)	2.68 (0.83–8.7)	2.97 (0.34–4.23)
History of psychiatric illnesses (yes vs. no)	1.44 (0.61–3.43)	2.16 (0.39–11.90)
BSRS score	1.08 (1–1.18)	0.92 (0.79–1.06)

*$p < 0.05$; **$p < 0.01$, significant differently

In univariable logistic regression model, each independent variable was included in separate models. In multivariable logistic regression model, independent variables included age, education level, marital status, age at first methamphetamine use, SDS score, VAS for craving score, duration of methamphetamine use, polysubstance use status, history of induced psychosis after methamphetamine use, AUDIT score, FTQ score, history of suicide attempts, psychiatric medical history and BSRS score

AUDIT, Alcohol Use Disorder Identification Test; BSRS, Brief Symptom Rating Scale; CI, confidence interval; FTQ, Fagerstrom Tolerance Questionnaire; ICM, intensive case management; OR, Odds ratio; TAU, treatment as usual; SDS, Severity of Dependence Scale; VAS, Visual Analogue Scale

In the ICM group, the treatment completion rate is 77.42%, which is higher than that of the TAU group. But no statistically significant difference was found. In the multivariable logistic regression model, education levels ($p < 0.05$) and suicide attempt history ($p < 0.05$) were both significantly associated with treatment completion (Table 4).

Discussion

As shown in our study results (Table 2 and Figure 1), we found that participants in the ICM or TAU groups showed significantly lower relapse rates ($p < 0.05$), more reduced methamphetamine dependence severity ($p < 0.01$), more decreased craving for methamphetamine ($p < 0.01$), and more decreased psychological distress ($p < 0.05$) over time during or after the treatment compared to baseline conditions. But we found no significant differences in treatment outcomes between the ICM and TAU groups regarding relapse, methamphetamine dependence severity, craving for methamphetamine, and psychological distress severity (Table 2), despite participants in the ICM group having higher baseline clinical severity, which may suggest potential confounding by indication.

For the entire group, those who had significantly higher severity of substance dependence ($p < 0.05$) and significantly higher craving levels at baseline ($p < 0.01$) were at significantly increased risk of relapse during the one-year follow-up (Table 3). Furthermore, patients with higher education levels ($p < 0.05$) and no history of suicide attempts ($p < 0.05$) were significantly associated with higher treatment retention rates (Table 4). To the best of our knowledge, our study is the first to provide evidence for the potential benefits of the ICM program in individuals with MUD who manifest more severe psychiatric problems.

As shown in Table 1, we found that the ICM group had a significantly higher prevalence of comorbid psychiatric conditions, including depressive ($p < 0.01$) and anxiety ($p < 0.01$) disorders and suicide ($p < 0.01$). Additionally, individuals in this group had higher SDS scores despite a shorter total duration of methamphetamine use. This might suggest that these individuals had a more rapid and severe disease progression, implying a poorer prognosis and a difficult-to-treat feature. Prior studies showed that individuals with MUD who have had psychiatric comorbidities have a poorer prognosis [22, 23]; thus, mental health providers should improve the treatment strategies by developing an integrated model of care that addresses both substance use disorder and psychiatric comorbidity [22, 23], thereby fulfilling the needs of these patients with more complicated psychopathology. In reality, clinicians are more inclined to refer individuals with more severe illness profiles to the ICM program owing to the anticipation of a poorer prognosis and, hence, expect that additional treatment provided though ICM can facilitate treatment outcomes. Our ICM program is based on an integrated model that allows a more comprehensive assessment of patients' medical needs, allowing for the provision of personalized and thorough interventions. In our study, the comparable improvements noted in the ICM group relative to the TAU group for 12 months indicate that the ICM approach holds promise in those who have a more complicated psychological profile and thus might benefit from higher-intensity case management to enhance treatment outcomes to a level equivalent to that of individuals with less severe conditions [24, 25].

Several risk factors for methamphetamine use relapse were determined (Table 3). These factors included a significantly lower educational attainment ($p < 0.05$) and significantly higher craving severity ($p < 0.01$) [26-30]. Analogously, several prior reports, including ours, also demonstrated that individuals who had higher baseline craving levels were at a higher risk of relapse [2, 31, 32]. Craving is often used as a predictive factor in addiction treatment research [33, 34]. Measuring craving using VAS significantly predicts whether methamphetamine users will relapse during treatment [31]. Also consistent with our findings, research exploring risk factors of methamphetamine relapse also demonstrated a correlation between relapse and a lower education level [30, 35-37]. A higher level of education can prevent or delay substance use onset and the subsequent development of substance use disorders, while also providing better cognitive skills that contribute to treatment success [35]. Through the identification of these risk factors associated with relapse, we can tailor our treatment strategies. For instance, if we determine a lower educational attainment or higher craving severity during the initial assessment, enhanced care can be offered, reducing the risk of substance relapse, such as arranging entry into the ICM group for intensified case management, focusing on craving management or considering the use of craving-suppressant medications. These interventions hold potential benefits for individuals dealing with substance use disorders.

Treatment retention rate and relapse rate are distinct factors. While treatment retention does not have a direct correlation with relapse, research indicates that treatment duration is a factor associated with a lower relapse rate [38]. This underscores the importance of identifying the retention factors that might also be treated as a protective factor associated with better outcomes [38, 39]. Lower educational attainment ($p < 0.05$) and a history of suicide attempts ($p < 0.05$) were found to be significantly correlated with lower treatment retention rates (Table 4). In line with our expectations and consistent with the previously mentioned risk factors, lower educational attainment emerges as a notable factor. However, regarding suicide, a striking characteristic among suicide attempters is the high incidence of substance abuse and dependence [40]. Remarkably, up to 40% of patients seeking treatment for substance dependence have reported a history of suicide attempts [41]. The co-occurrence of mental illness and substance abuse significantly increases the risk of suicidal behavior [40, 41]. Managing individuals with this dual diagnosis is tedious in clinical settings and is often associated with a higher likelihood of treatment dropout [42].

Study limitations

The readers are warned not to over-interpret the study results because the study has four limitations:

- The cohort consisted entirely of male participants under deferred prosecution from a single urban center, limiting generalizability across gender, legal contexts, and geographic regions. The relatively small sample size restricts

Table 4. Univariable and multivariable logistic regression to examine the association of treatment completion (dependent variable) with demographic and clinical variables (independent variables) for the entire sample (n = 124)

Variables	Univariable logistic regression, OR (95% CI)	Multivariable logistic regression, OR (95% CI)
ICM group versus TAU group	1.71 (0.67–4.41)	2.36 (0.52–10.64)
Demographic related variables		
Age (years)	1.02 (0.98–1.07)	0.98 (0.72–1.32)
Less than and equal to high school versus Higher than high school	0.33 (0.15–0.74)*	0.16 (0.04–0.66)*
Married versus other	1.83 (0.59–5.69)	2.32 (0.51–10.59)
Substance use-related variables		
Age of first methamphetamine use (years)	1.05 (1.01–1.1)*	1.06 (0.78–1.44)
SDS score	0.93 (0.8–1.08)	0.83 (0.64–1.07)
VAS for craving score	0.94 (0.82–1.09)	1.27 (0.98–1.65)
Duration of methamphetamine use (years)	0.97 (0.93–1.01)	1.09 (0.8–1.48)
Urine test positive at baseline (yes vs. no)	0.33 (0.14–0.75)*	0.38 (0.11–1.3)
Polysubstance use (yes vs. no)	0.6 (0.27–1.31)	1.15 (0.35–3.83)
History of psychosis associated with methamphetamine use (yes vs. no)	0.87 (0.32–2.4)	4.62 (0.61–35.27)
AUDIT score	0.95 (0.89–1.02)	0.99 (0.89–1.11)
FTQ score	0.86 (0.76–0.97)*	0.92 (0.78–1.09)
History of suicide attempts (yes vs. no)	0.29 (0.1–0.8)*	0.14 (0.02–0.85)*
History of psychiatric illnesses (yes vs. no)	0.58 (0.25–1.37)	0.32 (0.06–1.75)
BSRS score	0.92 (0.85–1)	0.96 (0.84–1.1)

*$p < 0.05$ significant differently

In univariable logistic regression, each independent variable was included in separate models, In multivariable logistic regression, all the variables listed in this table were included

AUDIT, Alcohol Use Disorder Identification Test; BSRS, Brief Symptom Rating Scale; CI, confidence interval; FTQ, Fagerstrom Tolerance Questionnaire; ICM, Intensive Case Management; OR, Odds ratio; TAU, treatment-as-usual; SDS, Severity of Dependence Scale; VAS, Visual Analogue Scale

statistical power and may lead to imprecise effect estimates and increased error risks. Future research should include diverse populations and larger samples to enhance external validity.

- Predetermined criteria for enrolling individuals in the ICM program were not established. The enrollment process was based on clinically flexible decisions, which may have introduced selection bias. But this reflects the result of an observational study that was done in a real-world practice setting.
- In this study, the study participants examined were focused on methamphetamine use, and the conclusions may not be appropriate for other illicit drug types.
- The sample collected in this study consisted of methamphetamine users under deferred prosecution, which limits its generalizability to other populations of methamphetamine users.
- Relapse data may be under-reported due to self-report bias and limited detection windows, potentially affecting the accuracy of treatment outcomes.

Summary

The application of ICM in treating comorbid MUD with co-occurring psychiatric problems was shown to be beneficial. The use of this model should be promoted, and further research should be performed to provide additional evidence regarding its efficacy on various outcomes.

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Data Sharing Statement

Datasets generated and/or analyzed in this study can be shared upon a reasonable request to the corresponding author.

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Conflicts of interest

All authors declare no conflicts of interest in writing this article.

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