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Comparison of the Cigarette Dependence Scale with Four Other Measures of Nicotine Involvement: Correlations with Smoking History and Smoking Treatment Outcome in Smokers with Substance Use Disorders

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Abstract

The Cigarette Dependence Scale (CDS) was developed to assess principal aspects of smoking dependence. In a French longitudinal survey, CDS showed stronger relationships to urge and change in smoking rate than the Fagerström Test for Nicotine Dependence (FTND). Neither measure predicted abstinence at follow-up in that survey but there was no treatment or cessation induction. The present study investigated concurrent and predictive validity of the CDS in a treatment population by comparing the CDS to the FTND and other measures of tobacco involvement as (1) a correlate of smoking and cessation history and (2) a predictor of short-term smoking abstinence among smokers with substance use disorders (SUD) receiving smoking treatment.

Methods—Smokers (10+ cigarettes per day) in substance treatment received brief advice and nicotine patch for 8 weeks; half also received contingent vouchers for smoking cessation. Assessments were conducted pretreatment and 7, 14 and 30 days after treatment initiation, with abstinence verified biochemically.

Results—At baseline (n = 305), the 12-item and 5-item CDS versions showed excellent and marginal reliability, respectively. FTND shared 43 and 61% of variance with CDS-12 and CDS-5, respectively. FTND and CDS scales correlated positively with cigarettes per day, and negatively with time to first cigarette, motivation to quit and age at first daily smoking. Only CDS correlated with number of past quit attempts. Neither CDS nor FTND predicted abstinence within treatment, unlike the motivation measure and time to first cigarette.

Contributors

The five authors together designed the study in a series of meetings and wrote the protocol. Author Rohsenow was PI of the grant and the parent treatment study and initiated the idea that we compare these measures, conducted the statistical analysis, and wrote the first draft of the manuscript. Author Martin was the coordinator for running the study, updated the literature searches and provided guidance on the statistical analysis. Author Colby provided additional literature citations and statistical guidance. Author Monti assisted in the study design and procedures and writing. All authors contributed to the writing of and have approved the final manuscript.

Conflict of Interest

No author has a financial or personal conflict of interest with this study.

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Conclusion—In moderate-heavy smokers with SUD in smoking treatment in the U.S., the CDS is largely equivalent to the FTND as an indicator of tobacco dependence but the CDS-5 is less reliable. Motivation was the most consistent predictor of outcome, and time to first cigarette was the only tobacco dependence measure that predicted smoking abstinence during treatment.

1. Introduction

1.1

The Fagerström Test for Nicotine Dependence (FTND; Heatherton et al., 1991) is a widely-used brief self-report measure validated to assess degree of dependence on nicotine. The Cigarette Dependence Scale (CDS; Etter et al., 2003), a reliable and valid newer measure designed to cover the principal aspects of diagnostic definitions of cigarette dependence, was developed by surveying European smokers by mail, internet and email. The original version has 12 items (CDS-12) that map onto DSM-IV and ICD-10 dependence criteria, except for tolerance, i.e., compulsion to smoke, withdrawal symptoms, loss of control, allocation of time to smoking, neglect of other activities to smoke, and persistence of use despite harm, excluding tolerance. A version containing a subset of 5 items (CDS-5) was also developed that covers fewer of these criteria. Three studies found both versions to have excellent internal consistency reliability with a single factor (Etter, 2008; Etter et al., 2003; Etter et al., 2009) while a fourth study found borderline acceptable reliability for the shorter version (Stavem et al., 2008). The “dependence” items that were used to determine the construct validity of these measures included only smokers’ ratings of how addicted they were to cigarettes, number of cigarettes smoked per day, and days smoked, with daily smokers scoring higher than occasional smokers (Etter et al., 2003). When compared to a diagnostic tool, the Mini International Neuropsychiatric Interview (Lecrubier et al., 1997; Sheehan et al., 1998), the CDS-12 had the largest area under a Receiver Operator Characteristic curve, followed by the CDS-5 and the FTND, but with fairly small differences among the measures (Etter, 2008). Also, CDS scores were more closely correlated with urge to smoke during a previous quit attempt and with daily smoking rate than were FTND scores (Etter et al., 2003). However, in a non-clinical sample, the FTND and CDS scales all showed equivalent relationships to number of prior quit attempts (Stavem et al., 2008). The only study of construct validity that used a clinical sample recruited only light smokers (< 10 cigarettes per day); the CDS and FTND had equivalent associations with baseline variables (Okuyemi et al., 2007). The CDS has not been validated in a clinical sample of moderate and heavy smokers, a necessary step before considering the measure as a clinical tool, particularly since evidence in non-clinical populations was mixed.

The ability of smoking dependence measures to prospectively predict smoking cessation outcomes after treatment is important for validating any measure of nicotine dependence and demonstrating its utility for clinical purposes. In the first CDS study, neither CDS nor FTND predicted abstinence at follow-up but there was no treatment or cessation induction involved (Etter et al., 2003). In the second study, while no formal treatment was involved, the participants were 13,697 daily French-speaking smokers (mean age 29 years) who accessed a quit smoking Web site (Etter, 2008). While results are limited to a small subset of the original respondents and thus potentially biased (i.e., only 21% answered an emailed survey 8 days later and only 8% completed a survey 6 weeks later), among these respondents higher scores on the CDS-12, but not the CDS-5 or FTND, predicted self-reported smoking 7-day abstinence at 8 days and 6 weeks. Higher CDS scores at baseline correlated with intending to quit smoking within 30 days in that study but no comparisons with other dependence measures were made for that measure. A subsequent study (Courvoisier & Etter, 2010) used 2206 daily smokers (mean age 38 years) from the same survey Web site as Etter (2008), with 8-day follow-up data via email on 21% and 31-day data on 22% (no overlap in participants between the two publications). This time, the abstinence criteria were self-

reported 24 hour abstinence at 8 days and 7-day abstinence at 31 days. Mixed results were found. Both the CDS and FTND measures predicted smoking cessation at 8 days, with slightly better prediction by the two CDS measures, but the CDS measures did not predict 31-day abstinence while the FTND did. Unfortunately, these analyses all covaried baseline intention to quit and confidence in ability to quit even though they are inherently part of the phenomenon being studied (see Miller & Chapman, 2001). Thus, evidence is mixed as to the relative abilities of the CDS and FTND measures to predict smoking abstinence in smokers using a smoking cessation Web site. While the FTND has been found to be a predictor of unverified self-reported smoking outcomes in studies in England and Canada (Fidler, Shahab & West, 2010; Kozlowski et al., 1994), the relative values of the CDS and FTND as smoking cessation predictors have not been investigated in a clinical smoking treatment population. Before clinicians can consider using the CDS, information is needed as to whether it has any advantages over the FTND in clinical settings.

1.2

The present secondary analysis study was prospectively designed to compare associations between the CDS and FTND and other measures of tobacco involvement, and as predictors of smoking cessation during the first month after starting smoking treatment, among moderate to heavy smokers who were recruited from a treatment program for people with substance use disorders (SUD). Since people with SUD have inordinately high rates of smoking with lower success rates than other smokers (Allen, Sacco, Weinberger & George, 2007; Budney, Higgins, Hughes & Bickel, 1993; Hughes & Kalman, 2006; Roll, Higgins & Badger, 1996), valid instruments that are predictors of treatment success are particularly needed in this population. Correlations of the CDS with other baseline measures of tobacco involvement can indicate the relative value of the CDS as an indicator of dependence, and using the measure to predict outcome indicates the heuristic value of the CDS relative to other predictors in indicating who will have the most difficulty quitting smoking. Intention-to-treat analyses were performed so that data from all smokers who started treatment would be analyzed, unlike in the previous studies of the CDS. Also, unlike the previous studies, biological confirmation was used to ascertain 7-day point-prevalence abstinence at each follow-up point. The hypothesis was that the CDS would perform as well as or better than the FTND in this population, given its content. Also, both CDS and FTND were compared to several other measures of tobacco involvement and with motivation to quit smoking when investigating their value as predictors of smoking abstinence during treatment. Given that more knowledge is needed about effective ways to promote smoking cessation in this population, it is important to know which assessment methods have the most heuristic value, particularly in predicting smoking cessation outcomes.

2. Methods

2.1 Participants

Participants were 305 smokers with SUD in residential substance treatment who had smoked 10 or more cigarettes per day for the past 6 months (excluding times when in restricted environment or ill) who were medically eligible for nicotine patch and not involved in any smoking cessation treatment. Exclusionary criteria included current use of any smoking cessation treatment or medication, psychosis, or medical exclusions for nicotine patch. Subjects did not need to be motivated to quit smoking to participate.

2.2 Procedures

In the study, all received smoking counseling (4 weeks) and transdermal nicotine replacement, with half randomized to contingency management (CM) for smoking cessation (n = 155) and half to noncontingent payments (NR; n = 150). No participant was allowed to

receive any other pharmacotherapy for smoking during this time. Assessments were conducted at baseline and 7, 14 and 30 days after smoking treatment initiation. If breath alcohol was not < .02 g%, the interview was rescheduled. Self-reported past 7-day abstinence status was verified by collecting expired carbon monoxide (CO) using a Bedfont Micro Smokerlyzer®.

2.2.1 Measures—Substance use or dependence diagnoses were made using the criteria of the Structured Clinical Interview for DSM-IV- Patient version (First et al, 1995), administered by trained research staff. At baseline, the following measures were administered: the CDS (included only for the purposes of the present analyses), FTND, a demographic questionnaire, and a smoking history questionnaire that included current number of cigarettes smoked per day, minutes to first cigarette of the day (scored continuously), number of past smoking quit attempts that lasted at least 24 hours, age they started daily smoking, and number of years of daily smoking. Time to first cigarette may be the best index of ability to quit smoking, per Transdisciplinary Tobacco Use Research Center (2007). In addition, the Contemplation Ladder (Biener & Abrams, 1991) was administered to assess motivation to reduce or quit smoking using a 10-point fully anchored scale. The CDS was scored using 5-item and 12-item methods (Etter et al., 2003) in order to make comparisons with other studies and determine reliability and validity in a clinical population. At each follow-up assessment, using a daily calendar, participants were asked about last 7 days smoking (number of cigarettes per day); reports of complete abstinence were considered confirmed if CO of 6 ppm.

2.2.2 Treatment approach—All participants were provided with brief (20–30 min) smoking counseling weekly for 3 weeks and nicotine patch for 8 weeks, and randomized to receive 19 days of contingent vouchers for smoking reduction then abstinence (if in CM) or noncontingent rewards (if in NR). Four sessions of smoking counseling were given on days 1, 7, 14, and 19 of the CM or NR period. The Brief Advice counseling strategy was based on the approach developed for motivating smokers who have not sought smoking treatment (Manley et al., 1991; Fiore, 2000). It had five discrete components: (1) Assess initial interest in cessation; (2) Advise the patient to quit smoking, with discussion of concerns that smokers with SUD see as barriers (Asher et al., 2003); (3) Assist the patient in quitting; (4) Assess interest in quitting; and (5) Arrange booster sessions. Participant were all given the self-help manual “Freedom From Smoking for You and Your Family” of the American Lung Association (Strecher et al., 1989), access to a variety of tailored smoking cessation pamphlets, and daily supplies of hard mint candies. Nicotine patch was 21 mg/day for 4 weeks, 14 mg/day for 2 weeks, 7 mg/day for 2 weeks. Contingency management (CM) involved daily CO monitoring for 19 days in all participants, reinforcement of attendance in all participants, and either (1) contingent reinforcement of breath CO samples meeting CO reduction and abstinence criteria (CM condition) or (2) equal-value reinforcement not contingent upon these criteria (NR condition). Effects of treatment type will be reported elsewhere after the study is complete. All participants received smoking advice with counseling and nicotine replacement, a typical recommended approach to encourage smoking cessation in clinical settings, and since there is no theoretical reason to believe that our study hypotheses would be affected by content of treatment, based on Fiore (2000), analyses are investigated while combining CM versus NR.

2.2.3 Human protections—All procedures were approved by the Institutional Review Board of Brown University. All payments were made in the form of merchandise certificates to area stores.

2.3 Data analysis methods—Internal consistency reliability of each measure was checked using Cronbach’s alpha. Variables were checked for normality; minutes to first cigarette and number of past 24-hour quit attempts were log transformed which corrected skewness (untransformed values are presented for ease of interpretation). Pearson’s correlations of the two CDS scales with each other and with the FTND were investigated to indicate degree of shared variance (r^2). Pearson’s correlations were used to compare the three measures to smoking history variables, with the hypothesis-wide number of tests at $p < .05$, acceptable per Dar et al. (1994). The CDS measures and FTND were used to predict 7-day confirmed point-prevalence abstinence at 7 days, 14 days and 1 month, using separate logistic regressions, entering treatment condition as a covariate to control for its variance. For comparison with other indices of tobacco involvement, the same logistic regressions were also run using minutes to first cigarette, cigarettes per day, and Contemplation Ladder as the predictors.

3 Results

3.1 Participant characteristics

Participant characteristics are displayed in Table 1, along with means and standard deviations for each smoking measure. In this study, 72% met criteria for cocaine dependence, 68% for alcohol dependence, 58% for opiate dependence, 38% for marijuana dependence, and 0.7% had benzodiazepine dependence; 47% met criteria for both alcohol dependence and one or more other drug dependence diagnosis; 15% met criteria for more than one drug dependence but not alcohol dependence. The mean response on the Contemplation Ladder (see Table 1) fell between “I often think about quitting smoking, but I have no plans to quit” and “I definitely plan to quit smoking in the next 6 months”. Participants attended a mean of 3.7 of the four counseling sessions. Number of participants with data included 305 at baseline and each follow-up since any people with missing data at follow-up were considered to be smoking.

3.2 Correlations with smoking measures

The 12-item CDS had an alpha of .84 (excellent) and the 5-item CDS an alpha of .61 (borderline acceptability). The 5-item and 12-item CDS correlated highly ($r = .84$) with each other. FTND correlated $r = .66$ with CDS-12, $r = .78$ with CDS-5, indicating conceptual overlap especially with the shorter CDS version (61% shared variance), but with considerable separate variance. All three measures significantly correlated in expected directions with greater number of cigarettes smoked per day, fewer minutes to first cigarette, earlier age of first daily smoking, and lower Contemplation Ladder ratings (see Table 1). The magnitudes of the correlations of the FTND with these measures were larger than for the correlations with the CDS-12 scale but similar to the correlations with the CDS-5. Only the CDS scales, not the FTND, significantly correlated with number of past 24-hour quit attempts although the correlations for all were low (less than 3% of variance as indicated by r^2).

3.3 Predicting smoking outcome

Smoking abstinence rates are shown in Table 1. In logistic regressions, neither the CDS nor the FTND predicted verified smoking abstinence status at any time point (see Table 2). Both minutes to first cigarette and Contemplation Ladder scores significantly predicted 7-day and 14-day smoking abstinence, and Contemplation Ladder predicted 30-day abstinence outcomes. Abstinence at outcome was predicted by greater motivation to quit smoking and less nicotine dependence in terms of time to first cigarette but not by nicotine dependence as assessed by FTND or CDS. For exploratory purposes, analyses were re-run within each treatment condition separately. The relationships were similar, but due to the loss of power,

fewer reached significance: two fewer in NR (one no longer significant for minutes to first cigarette, $p = .08$, one for Contemplation Ladder, $p = .06$) and three fewer in CM (two for minutes to first cigarette, $p = .16$ and $.06$, one for Contemplation Ladder, $p = .10$).

4 Discussion

4.1

The CDS-5 is as highly correlated with pretreatment smoking history and severity of nicotine dependence as is the FTND in smokers with SUD engaged in smoking cessation treatment, but the relationships are weaker for the CDS-12. This suggests that the CDS-12 may not be as good an indicator of tobacco dependence among smokers in a clinical setting as is the CDS-5, although the CDS-5 shows only borderline acceptable internal consistency reliability. The low reliability for CDS-5 is consistent with general population results (Stavem et al., 2008) but lower than found in a survey of smokers using nicotine gum (Etter et al., 2009). Both versions of the CDS are significantly related to number of past 24-hour quit attempts, unlike the FTND, although less than 3% of variance is accounted for by any of the measures. In non-clinical smokers in Norway (Stavem et al., 2008), none of the scales was associated significantly with number of past quit attempts. Thus, in general the CDS-5 is as good an indicator of pretreatment tobacco involvement as is the FTND in these smokers in treatment.

In contrast, neither the CDS nor the FTND was a significant predictor of smoking abstinence within the first month of treatment. While FTND did predict smoking outcome with smokers not selected for SUD in two studies (England and Canada), it is not clear if the difference was because of the population differences, because those outcomes were not biochemically verified, or because both studies were much larger (Fidler et al., 2010; Kozlowski et al., 1994). In the current study, time to first cigarette did predict abstinence at 7 and 14 days of treatment. Therefore, time to first cigarette is the measure of tobacco dependence with the most predictive validity and heuristic value in these smokers in smoking cessation treatment. The predictive value of time to first cigarette is consistent with results from the Transdisciplinary Tobacco Use Research Center (2007). However, pretreatment motivation was the best predictor of smoking abstinence of all the measures, being the only measure to consistently predict outcome at all three time points, while time to first cigarette was not predictive after the first 14 days. Therefore, among smokers who vary widely in motivation to quit, those who report the most motivation will have the greatest success, even when using a motivational strategy (Manley et al., 1991) that is designed for smokers who have not sought treatment for smoking.

4.2 Limitations and Future Directions

The study was limited to smokers who did not need to be ready to quit smoking. The results are also limited to smokers in treatment for substance dependence, although this is an important clinical population of smokers due to the difficulty they have quitting smoking and their increasing proportion among current smokers as more smokers in the general population quit. In smokers in treatment in England and in Canada, FTND and minutes to first cigarette both predicted self-reported smoking relapse (Fidler et al., 2010; Kozlowski et al., 1994), so results could be different among a less restricted population of smokers in treatment. Only one pool of urban smokers was used; replication is needed in other populations. One of the challenges in any instrument-validation study is the selection of measures against which to validate the target instrument. Since any measure that is considered a “gold standard” is only an imperfect stand-in for behavior, with error variance, additional measures of tobacco dependence and involvement were included to provide more information. However, different choices of measures could have been made. Despite these

limitations, valuable evidence was provided about the relative value of each of the measures as an indicator of tobacco involvement and as a predictor of outcome for smokers with SUD in smoking treatment.

4.3 Conclusions

In conclusion, the CDS shows validity and the longer form shows excellent reliability in this population. The CDS-5 is equivalent to the FTND as an indicator of tobacco involvement measures related to dependence -- with two of its five items the same as items on the FTND, this should be expected. The CDS-12 has better internal consistency reliability but has weaker relationships with other measures of tobacco involvement related to dependence. No heuristic advantage is seen for the CDS in predicting short-term smoking abstinence in smokers with SUD in smoking treatment. Minutes to first cigarette and pretreatment motivation to quit smoking are more useful as predictors of short-term success in quitting smoking, consistent with the recommendations of the Transdisciplinary Tobacco Use Research Center (2007). The fact that self-reported motivation to quit smoking was the strongest predictor shows the value of this subjective measure over various measures of dependence when needing to predict how well smokers will respond to an intervention designed to induce smoking cessation.

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Highlights

- The Cigarette Dependence Scale has not been studied before in moderate-heavy smokers in treatment
- The Cigarette Dependence Scale worked as well as the Fagerström Test for Nicotine Dependence
- The Cigarette Dependence Scale did not predict abstinence during treatment
- Time to first cigarette and motivation best predicted abstinence during treatment

Table 1**Characteristics of Participants and Scores on Smoking Measures**

	Mean (S.D.) or n (%)
<u>Demographics</u>	
Age	37.8 (9.9) (range = 19–62)
Education	12.1 (2.1) (range = 5–18)
Male	204 (67%)
White	262 (86%)
Black	29 (3%)
American Indian	8 (3%)
Asian or mixed race	6 (2%)
Hispanic	25 (8%)
Married or living together	35 (12%)
Employed full or part time	9 (3%)
Alcohol use diagnosis	Dependence 68%; abuse 8%
Drug use diagnosis	Dependence 77%; abuse 3%
<u>Smoking History, Rate and Dependence</u>	
Cigarettes per day	19.9 (7.1)
Cigarette Dependence Scale – 12 item	52.2 (5.7)
Cigarette Dependence Scale – 5 item	20.1 (2.5)
FTND score	6.0 (1.9)
Years smoked regularly	21.4 (10.3)
Minutes to first cigarette of day	17.6 (22.1) (median = 8.0)
Number of times quit 24 hours or more	2.6 (10.6) (median = 1.0)
Contemplation Ladder	5.4 (1.6)
<u>Percentage (out of n = 305) with biochemically verified 7-day abstinence at outcome</u>	
At 7 days	94 (31%)
At 14 days	110 (36%)
At 30 days	27 (9%)

Note: When distribution is significantly skewed, median is provided as additional information.

FTND = Fagerström Test for Nicotine Dependence total score

Table 2Correlations (*r*) of baseline smoking history measures and motivation with FTND and both CDS versions

	FTND	CDS-5	CDS-12
Minutes to first cigarette ^a	-.69**	-.66**	-.44**
Cigarettes per day	.59**	.57**	.48**
Contemplation Ladder	-.23**	-.25**	-.18**
Number of past 24 h quits ^a	-.08	-.13*	-.17*
Age first smoked daily	-.13*	-.15*	-.16*

^aLog-transformed to correct skewness*
p < .01.**
p < .001.

Table 3

Logistic regression results relating measures of dependence, use and motivation to quit, while covarying treatment condition, to smoking abstinence outcomes at 7 days, 14 days, and 30 days after initiating smoking treatment.

	7-day abstinence			14-day abstinence			30-day abstinence					
	Odds ratio	95% CI	Wald	p	Odds ratio	95% CI	Wald	p	Odds ratio	95% CI	Wald	p
CDS-12	0.97	0.93–1.01	2.16	<i>ns</i>	0.98	0.94–1.02	1.19	<i>ns</i>	0.71	0.32–1.59	0.71	<i>ns</i>
CDS-5	0.92	0.83–1.02	2.57	<i>ns</i>	0.94	0.85–1.03	1.72	<i>ns</i>	0.92	0.79–1.07	1.28	<i>ns</i>
FTND total score	0.95	0.83–1.09	0.51	<i>ns</i>	0.96	0.84–1.10	0.32	<i>ns</i>	0.92	0.75–1.13	0.66	<i>ns</i>
Minutes to first cigarette	2.01	1.07–3.78	4.75	.03	2.41	1.30–4.49	7.89	.005	1.89	0.75–4.76	1.83	<i>ns</i>
Cigarettes per day	0.99	0.96–1.03	0.21	<i>ns</i>	1.00	0.96–1.03	0.02	<i>ns</i>	0.99	0.93–1.05	0.21	<i>ns</i>
Contemplation Ladder	1.29	1.09–1.53	8.91	.003	1.23	1.05–1.45	6.71	.01	1.61	1.20–2.15	10.27	.001

All *df* = 1, *n* = 305.

CI = Confidence interval.

FTND = Fagerström Test for Nicotine Dependence total score.

CDS-12 = Cigarette Dependence Scale 12-item version.

CDS-5 = Cigarette Dependence Scale 5-item version.