Published in final edited form as:

Drug Alcohol Depend. 2009 October 1; 104(Suppl 1): S106–S114. doi:10.1016/j.drugalcdep.2009.05.012.

An Overview of Principles of Effective Treatment of Substance Use Disorders and their Potential Application to Pregnant Cigarette Smokers

Sarah H. Heil,

Departments of Psychiatry and Psychology, University of Vermont, Burlington, VT 05401

Teresa Linares Scott, and

Departments of Psychiatry and Psychology, University of Vermont, Burlington, VT 05401

Stephen T. Higgins

Departments of Psychiatry and Psychology, University of Vermont, Burlington, VT 05401

Abstract

Cigarette smoking remains a leading preventable cause of poor pregnancy outcomes and infant morbidity and mortality. Despite three decades of research encompassing more than 60 trials and 20,000 pregnant women, cessation rates produced by existing interventions are often low (< 20%), especially among socioeconomically disadvantaged women. This has led to a call for the development and testing of novel interventions. One strategy for identifying novel interventions for pregnant smokers is to examine efficacious interventions for other types of substance use disorders (SUDs). Pregnant smokers share many sociodemographic similarities with other sub-populations of individuals with SUDs, suggesting that interventions efficacious with the latter may also benefit the former. The National Institute on Drug Abuse's guide, "Principles of Drug Addiction Treatment: A Research-based Guide", presents empirically validated principles of effective treatments for other SUDs. The present report enumerates these principles, briefly describes some of the empirical evidence supporting them, and explores their potential application to the treatment of smoking during pregnancy. Overall, the results of this exercise suggest much promise for enhancing treatment outcomes for pregnant smokers by borrowing from and extending what has been learned with other populations with SUDs.

Keywords

pregnant women; smoking cessation; substance use disorders; treatment; empirically validated

Corresponding author: Sarah H. Heil, Ph.D., Rm. 1415, 1 So. Prospect St., Burlington, VT 05401, Phone: 802-656-8712, Fax: 802-656-5793, Email: sarah.heil@uvm.edu.

Role of the Authors: Dr. Heil conceived of the format for the manuscript and wrote the first draft. Drs. Linares Scott and Higgins both commented on and revised subsequent drafts of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of Interest: The authors declare they have no conflicts of interest.

Acknowledgement and Role of Funding Source. Preparation of this manuscript was supported by NIDA research grants RO1 DA014028, RO1 DA018410, and RO1 DA02249, and training grant T32 DA07242. NIDA had no further role.

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

1. Introduction

Cigarette smoking remains a leading preventable cause of poor pregnancy outcomes and infant morbidity and mortality (see Cnattingius, 2004; U.S. Department of Health and Human Services, 2001). Cataloging the grim consequences of smoking during pregnancy, including increased risk of placental abruption, placenta previa, fetal growth restriction, preterm birth, stillbirth, and sudden infant death syndrome (SIDS) (Cnattingius, 2004; Slotkin, 2008), underscores the gravity of this situation. The vast majority of research in this area has focused on brief (5–15 min) interventions such as brief advice from health professionals, pregnancy-specific self-help materials and feedback regarding serum-cotinine levels (see Lumley et al., 2004). Still, despite three decades of research encompassing more than 60 trials and 20,000 pregnant women and their infants (Lumley et al., 2004), cessation rates produced by existing interventions are often low (< 20%), especially among women who are socioeconomically disadvantaged (Ershoff et al., 2004; Melvin and Gaffney, 2004). This has led to a call to develop novel, more powerful interventions to address this important public health problem (Orleans et al., 2000).

One strategy for identifying novel interventions and approaches to treat pregnant smokers is to look to efficacious approaches for treating other types of substance use disorders (SUDs). Some readers may question whether pregnant smokers are similar enough to those with other types of SUDs, especially those using illicit drugs, that approaches would generalize from one population to the other. As Slotkin (1998) has noted, “both the press and the medical community continue to regard tobacco as separate from, and less serious than, illicit drugs of abuse (p. 933).” Data from clinical (Heil et al., 2008; Higgins et al., 2004; Pollak et al., 2007; Ruger et al., 2008) and community samples (e.g., Ebrahim et al., 2000; Mathews, 1998) reliably indicate that the typical pregnant smoker shares many characteristics with other populations with SUDs, including being young, unmarried, and having less than a high school education. Examination of data from the most recent National Household Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration, 2008), for example, indicates striking similarities between the sociodemographic characteristics of pregnant smokers and current users of marijuana, cocaine, and heroin (Table 1). Level of education is a particularly telling variable given its persistent and robust association with SUDs and numerous other health problems (Higgins et al., in press-a; Huisman et al., 2005; Steenland et al., 2002; Steenland et al., 2004). These data document sufficient similarities between pregnant smokers and other populations with SUDs to warrant exploration of whether pregnant smokers may benefit from efficacious treatment approaches developed for other types of SUDs.

There is an extensive literature documenting efficacious strategies for treating SUDs involving illicit drugs, much of it supported by the National Institute on Drug Abuse (NIDA). To foster more widespread use of scientifically based treatment components, NIDA publishes a guide, “Principles of Drug Addiction Treatment: A Research-based Guide” (National Institute on Drug Abuse, 2009). This guide presents 13 overarching principles that characterize effective treatment strategies and their implementation. These principles provide an empirically validated source of potentially new ideas for advancing treatment for the serious problem of smoking during pregnancy.

Each section of the present report begins with enumeration of one of NIDA’s principles of treatment for SUDs. We then briefly describe some of the empirical evidence from the broader SUDs treatment literature that supports each principle and explore that principle’s potential application to the treatment of smoking during pregnancy. In some cases, the principle has been applied to pregnant smokers and we will discuss the relative success of that application. For those principles that, to our knowledge, have not been applied to pregnant smokers, we provide examples of how they might be extended to this population. Two principles (#10

regarding detoxification and #13 regarding assessment for infectious diseases such as HIV/AIDS) are not discussed, as they do not appear to be directly germane to smoking cessation. In addition, two closely related principles (e.g., #4 and #8 regarding treatment service plans) are discussed together, for a total of 11 principles in 10 sections.

2. NIDA's Principles of Drug Addiction Treatment

2. 1. NIDA Principle #1: Addiction is a complex but treatable disease that affects brain function and behavior

2.1.1. Empirical evidence from the broader literature on treatment of SUDs—

SUDs are characterized by risky, impulsive behavior, most notably choices to continue using substances despite suffering a wide range of adverse consequences. While maladaptive behavior among patients with SUDs has been recognized for decades, recent technological advances in techniques like neuroimaging have allowed scientists to more clearly understand the relationship between SUDs, behavior, and brain function. For example, the role of dopamine in the reinforcing effects of drugs has been studied for decades, but more recently positron emission tomography (PET) studies have provided new evidence that may help explain why patients with SUDs have difficulty refraining from drug use. Results from a number of studies indicate that patients with a wide variety of SUDs have significantly lower D2 dopamine receptor availability in the striatum (see Volkow et al., 2004). It has been observed that the decreased availability of D2 dopamine receptors in the striatum is associated with reduced activity in the orbitofrontal cortex and the cingulate gyrus (Volkow et al. 1997), two brain areas involved in assessing reinforcer value. These dysfunctions could make it more difficult to alter the greater saliency of substances and associated stimuli versus other non-drug reinforcers observed in individuals with SUDs (see Garavan and Hester, 2007).

In addition to decrements associated with brain reward and reinforcement pathways, patients with SUDs also appear to have impairments in executive function, such as impulse control and behavior monitoring. While deficits have been observed on tests of executive function in patients with SUDs for many years (e.g., Ardila et al., 1991; Beatty et al., 1995), the use of functional neuroimaging has allowed more precise localization of deficits. For example, comparison of inhibitory control in cocaine users and non-drug-using controls using a go/no-go task performed in an fMRI scanner suggests that cocaine users have poorer inhibitory control and that this functional deficit is associated with reduced activity in the anterior cingulate and prefrontal cortices, two regions thought to be critical for inhibiting responding (e.g., Hester & Garavan, 2004). Other studies have noted additional prefrontal deficits in cocaine users associated with attention biases towards drug-related stimuli and compromised behavior monitoring (Garavan & Hester, 2007)

Advances in understanding of the relationship between SUDs, behavior, and brain function have implications for current treatments as well as the development of new treatments. In terms of current efficacious treatments, greater understanding of the neurobiology of SUDs may help elucidate their mechanism(s) of action. For example, contingency management (CM) is a reliably effective treatment for cocaine dependence (see Higgins et al., 2008). The imaging research described above with cocaine-dependent patients suggests that CM may be efficacious because it involves potent and salient alternative reinforcers and related contingencies that accommodate the deficits in D2 dopamine receptor density and prefrontal functioning commonly observed in this clinical population. Examples of new treatments include a number of medications (e.g., modafinil, deprenyl) that are currently being investigated regarding their ability to improve executive function in patients with SUDs (see Volkow et al., 2007).

2.1.2. Application and extension to pregnant smokers—

Risks of adverse effects on the fetus preclude utilizing brain-imaging techniques in pregnant smokers (The American

College of Obstetricians and Gynecologists, 2004). However, we know of no reason to believe that pregnant smokers should differ from other populations with respect to the impact of SUDs on brain and behavior. Studies among early postpartum women are of interest and could help elucidate processes involved in the strikingly high rates of postpartum relapse back to smoking seen even among women who successfully abstain for many months antepartum and early postpartum (Solomon & Quinn, 2004).

2. 2. NIDA Principle #2: No single treatment is appropriate for everyone

2.2.1. Empirical evidence from the broader literature on treatment of SUDs—

Much research has been directed toward documenting the wide heterogeneity in patient response to and predictors of treatment outcome. Although not all efforts to identify moderators and predictors of treatment outcome have been successful (e.g., Project MATCH Research Group, 1997), a number of characteristics have been identified, including age, psychiatric comorbidity, and polydrug abuse. A predictor of treatment response that has not received as much research attention as one might expect is baseline drug use severity. One area where it has been relatively well investigated and where there is good evidence that drug-use severity moderates treatment response is cocaine dependence. The relationship holds across studies using different treatment modalities as well as different definitions of cocaine use severity (e.g., having a cocaine positive sample at treatment intake, frequency of baseline use) (Carroll et al., 1991; Preston et al., 1998). Among the cocaine treatment studies involving CM interventions, there is experimental evidence that increasing the intensity of the treatment by increasing the monetary value of the incentives promotes a positive treatment response among otherwise treatment recalcitrant patients (Silverman et al., 1999). These results suggest that matching the intensity of treatment to patient baseline drug use characteristics, rather than using a one-size-fits-all approach, may be an efficacious strategy for treating SUDs. This type of approach falls into a larger category of adaptive treatment strategies, which are a growing area of interest in the SUDs treatment literature (see Drug and Alcohol Dependence vol. 88 suppl 2 2007 special issue on this topic).

2.2.2. Application and extension to pregnant smokers—Recognition that no single treatment approach is appropriate for all individuals is evident in the pregnant smokers literature. A number of studies have compared the characteristics of women who quit smoking once they learned of the pregnancy (spontaneous quitters) and women who continued to smoke (pregnant smokers). Results have demonstrated reliable sociodemographic differences between these groups indicating higher educational attainment and other measures of socioeconomic status (SES) among the spontaneous quitters (Solomon and Quinn, 2004). In terms of success with smoking cessation, the majority of spontaneous quitters remain abstinent through the pregnancy and early postpartum, but return to smoking by 6 months postpartum. Awareness of differences between these two populations helped researchers begin to tailor treatments; work with spontaneous quitters typically focuses on relapse prevention strategies while pregnant smokers receive interventions directed towards cessation. Results of these different approaches have been modestly successful to date (Lumley et al., 2004).

The literature on treating cocaine dependence suggests potential benefit from drawing further distinctions between patients within the pregnant smokers population based on drug use severity. Consistent with the cocaine treatment literature, there is a well-established relationship between smoking frequency and the likelihood of achieving and sustaining abstinence among pregnant smokers (Fingerhut et al., 1990; Higgins et al., in press-a; Mullen, 2004; Solomon and Quinn, 2004). What has not been tested among pregnant smokers, to our knowledge, is whether treatments that match intensity to smoking rates might improve cessation outcomes. Examining that possibility appears to be a promising and practical strategy for improving outcomes among pregnant smokers.

2. 3. NIDA Principle #3: Treatment needs to be readily available

2.3.1. Empirical evidence from the broader literature on treatment of SUDs—

Potential clients seeking treatment for SUDs are frequently lost to treatment because they fail to attend intake appointments, which are often scheduled many days after initial clinic contact (Festinger et al., 1995; Stark et al., 1990). A series of studies examining this topic among those dependent on illicit drugs culminated in an experimental study in which clients calling an outpatient cocaine treatment clinic were randomly assigned to intake appointments scheduled either the same day, or 1, 3, or 7 days later (Festinger et al., 2002). Subjects offered intake appointments approximately 24 h following initial clinic contact were more than four times as likely to attend the intake assessment as those scheduled later. To promote dissemination and incorporation of such findings, the Robert Wood Johnson Foundation and Center for Substance Abuse Treatment collaborated in sponsoring the Network for the Improvement of Addiction Treatment (NIATx). This network of community treatment programs uses process improvement strategies to make organizational changes to facilitate treatment entry and initiation and results from one study of 15 Network programs reported substantive declines in no-show rates and days to first treatment after a variety of organizational changes were made (Hoffman et al., 2008).

2.3.2. Application and extension to pregnant smokers—There is tremendous urgency to intervene with pregnant smokers due to adverse effects on the fetus that accumulate over time (e.g., Lieberman et al., 1994; MacArthur and Knox, 1988), as well as the limited duration of pregnancy. As such, the majority of interventions aimed at promoting smoking cessation during pregnancy are delivered in the prenatal care setting (Lumley et al., 2004), which likely facilitates treatment entry and also prompts the initiation of treatment early in the pregnancy. As a result of this approach, there has been little opportunity to research the impact of treatment availability among pregnant smokers. However, as the need for and potential benefit of more intensive interventions for pregnant smokers gain greater recognition, that may change (Heil et al., 2008). We know of no reason to believe that pregnant smokers should differ from other populations with SUDs with respect to the importance of this relationship between treatment availability and the likelihood of treatment entry, suggesting continued need for sensitivity to this relationship in the development of treatments for pregnant smokers.

2. 4. NIDA Principle #4: Effective treatment attends to multiple needs of the individual, not just his or her drug abuse

NIDA Principle #8: An individual's treatment and services plan must be assessed continually and modified as necessary to ensure that it meets his or her changing needs.

2.4.1. Empirical evidence from the broader literature on treatment of SUDs—

Achieving drug abstinence is the primary focus of a treatment plan, but most efficacious treatment approaches recognize that to achieve and maintain drug abstinence, patients also need to make major lifestyle changes. A seminal controlled trial on this topic examined whether the addition of counseling, medical care, and psychosocial services improves the efficacy of methadone maintenance in opioid-dependent patients (McLellan et al., 1993). Prior uncontrolled studies of the benefits of methadone maintenance suggested that patients showed decreases in drug use and illegal activity (e.g., Ball & Ross, 1991). However, it remained unclear whether methadone treatment alone was sufficient to engender such patient improvements or whether the addition of supportive services to methadone maintenance could further improve outcomes. Participants were randomly assigned to one of three treatments: 1) methadone maintenance plus counseling once per month (minimum services); 2) methadone maintenance plus basic counseling 2–4 times per month (standard services); or 3) methadone maintenance plus basic counseling 2–4 times per month and referrals to extended on-site medical/psychiatric, employment, and family therapy services as appropriate for each

participant (enhanced services). Patients receiving minimum services demonstrated minimal improvements in drug use and psychosocial functioning, while provision of standard services was associated with intermediate improvement in outcome and enhanced services resulted in the greatest improvement in treatment outcome (McLellan et al., 1993). Results from subsequent studies have further indicated that patients who receive additional, individualized services for their specific problems are more likely to remain in treatment and have better during-treatment and post-treatment outcomes (McLellan et al., 1997; McLellan et al., 1992, Hser et al., 1999; Carise et al., 2005).

2.4.2. Application and extension to pregnant smokers—We are aware of at least one controlled study examining the efficacy of a more comprehensive treatment in pregnant women (Belizan et al., 1995). Low SES women with high-risk pregnancies were randomly assigned to a multi-component intervention or usual prenatal care. The high intensity, manualized intervention involved 4–6 home visits (1–2 hours each) by specially trained female social workers or obstetric nurses. Intervention components included psychosocial support, education on health habits (e.g., better nutrition, reducing smoking, alcohol and other drugs, reducing physical workload, pregnancy and delivery information), and increased access to hospital facilities. The treatment plan was individualized to focus on components that were appropriate for each participant and changes were made at each visit as needed. Among women who were smoking at randomization, 24% of those in the intervention condition were abstinent at the end of pregnancy compared to 13% of those in the control condition. Intervention condition participants also learned significantly more warning signs of problems with the pregnancy and of labor. Considering the low SES status of most pregnant smokers and the persistent and robust association of low SES with poor pregnancy outcomes and other health problems (see Kramer et al., 2000; Huisman et al., 2005; Steenland et al., 2002; Steenland et al., 2004), the results of Belizan et al. suggest it may be worth expanding research efforts to include more comprehensive interventions that target smoking as well as other problem behaviors in this population.

2.5. NIDA Principle #5: Remaining in treatment for an adequate period of time is critical

2.5.1. Empirical evidence from the broader literature on treatment of SUDs—

Treatment retention has been demonstrated in many studies to be an important predictor of longer-term outcomes. For example, being retained in outpatient treatment or long-term residential treatment for 3 or more months has been associated with significant improvements in follow-up outcomes in several national studies of drug abuse treatment outcomes (see Condelli and Hubbard, 1994; Simpson, 1984; Simpson et al., 1997). Because of this association, treatment retention is frequently included in studies as an outcome measure, although questions have been raised about whether treatment retention is simply an indicator of positive outcomes or is a positive outcome in and of itself (e.g., Walker, 2009). At least one study with cocaine-dependent outpatients demonstrated that being retained in treatment for at least 12 weeks was associated with increased odds of abstinence during follow-up only when participants also achieved a sustained period of during-treatment abstinence; participants who were retained for at least 12 weeks but failed to achieve a period of sustained abstinence during treatment were no more likely to be abstinent at follow-up than participants who were retained for less than 12 weeks (Higgins et al., 2000). Together, these data suggest that both adequate treatment duration and a period of sustained abstinence are critical to giving patients the best chance for longer-term success.

2.5.2. Application and extension to pregnant smokers—As noted in prior sections, the majority of interventions for pregnant smokers researched to date have been focused on brief interventions that often involve only 1–2 sessions (Lumley et al., 2004). The high levels of treatment failure associated with them suggest that such brief interventions may be of

insufficient duration for many pregnant smokers. Of course, they also provide little opportunity to examine the impact of treatment retention and initial abstinence on longer-term outcomes in pregnant smokers. We know of no reason to believe that pregnant smokers should differ from other populations with SUDs with respect to relationships between treatment retention, initial abstinence, and longer-term outcome. Indeed, the robust relationship between abstinence in the initial weeks of treatment and longer-term cessation outcomes seen with cocaine dependent outpatients (Higgins et al., 2000) and in the general population of cigarette smokers (Kenford et al., 1994) has recently been documented among pregnant smokers receiving a more extended and intensive smoking cessation treatment (Higgins et al., 2006). So, there is already evidence in the pregnant smokers literature that early abstinence is critical to later abstinence, although how treatment retention fits into this relationship remains to be examined. As treatment development efforts in this area expand to include more intensive and comprehensive interventions for pregnant smokers, attention to enhancing treatment retention and achieving an initial period of sustained abstinence will be critical.

2.6. NIDA Principle #6: Counseling – individual and/or group – and other behavioral therapies are the most commonly used forms of drug abuse treatment

2.6.1. Empirical evidence from the broader literature on treatment of SUDs—The past three decades have seen significant progress in the development of efficacious behavioral therapies for the treatment of SUDs. Cognitive behavior therapy (CBT), CM, couples and family therapy, and a variety of other types of behavioral treatments have all been shown to be efficacious, stand-alone treatments for many SUDs (see Carroll & Onken, 2005). For example, results from a recent meta-analysis indicated that CBT (n=13 studies) and CM (n=14 studies) each produced moderate effect sizes in studies targeting cocaine, opiate, marijuana, and polysubstance abuse (Dutra et al., 2008). In addition, combining behavioral interventions appeared to have better results than either approach alone: two studies examining CBT plus CM for the treatment of cocaine dependence and opiate dependence resulted in large effect sizes (Dutra et al., 2008). Overall, the scientific literature overwhelmingly supports the efficacy of behavioral treatments for SUDs. Future efforts to improve treatment outcomes by combining efficacious behavioral treatments will likely further enhance the contribution of behavioral interventions to the treatment of SUDs.

2.6.2. Application and extension to pregnant smokers—Behavioral therapies are the most commonly used interventions with pregnant smokers as well, at least in part because of concerns about the safety and efficacy of pharmacotherapies. Behavioral interventions are efficacious with pregnant smokers (Lumley et al., 2004), but quit rates are generally low. The best outcomes among pregnant smokers have been observed in studies examining interventions that more closely match the intensity of efficacious behavioral interventions for the treatment of other SUDs, like those described in the prior section. One early report describes a landmark study in which low SES women with high-risk pregnancies were randomly assigned to an intensive smoking cessation intervention or usual prenatal care (Sexton and Hebel, 1984). The intervention provided encouragement and assistance to stop smoking through behavioral strategies, social support, education, and practical guidance, and was delivered during home visits and frequent interactive mailings and phone calls. Smoking cessation rates at the end of pregnancy among women still smoking at the start of the study were greater in the experimental than control conditions (32% vs. 7%) as was average birth weight. This study provided early evidence that more intense behavioral interventions are feasible and produce fundamentally important benefits for the infant. Interestingly, rather than continuing with this type of treatment approach, the vast majority of subsequent research in this area has focused on brief, low-intensity behavioral interventions.

Among the more intensive behavioral interventions currently being investigated with pregnant cigarette smokers is voucher-based CM, an intervention wherein women earn vouchers exchangeable for retail items contingent on biochemically-verified abstinence from recent smoking. To date, three reports have demonstrated the efficacy of this approach in promoting smoking cessation during pregnancy and postpartum (Donatelle et al., 2000; Heil et al., 2008; Higgins et al., 2004; see Higgins et al., in press-b). The cessation rates from these studies are several-fold above what is typically reported in educationally disadvantaged populations of pregnant smokers. In addition, one report also documented positive effects on fetal growth, further underscoring the promise of this treatment approach (Heil et al., 2008). More research will be necessary to determine the treatment parameters needed to reliably produce positive outcomes, but the results of these studies are encouraging and suggestive of the role that more intensive behavioral interventions may play in addressing the problem of smoking during pregnancy. In light of success with behavioral interventions to treat other SUDs as well as more intensive interventions like voucher-based CM and the Sexton and Hebel program, further developing and expanding the use of intensive behavioral interventions alone or in combination appears to be a viable avenue of research for increasing quit rates among pregnant smokers.

2.7. NIDA Principle #7: Medications are an important element of treatment for many patients, especially when combined with counseling and other behavioral therapies

2.7.1. Empirical evidence from the broader literature on treatment of SUDs—

Efficacious pharmacotherapies are available for the treatment of a number of types of SUDs, including methadone and buprenorphine for opioid agonist maintenance therapy (see Mattick et al., 2008) and disulfiram and naltrexone for alcohol dependence (see Hughes and Cook, 1997; Krystal et al., 2001). Most relevant to the present discussion are the pharmacotherapies for nicotine dependence (see Fiore et al., 2008). The most widely studied and used pharmacotherapies for managing nicotine dependence and withdrawal are nicotine replacement therapies, currently available in six different formulations. Bupropion, a non-nicotine medication, has been shown to approximately double rates of cessation compared with placebo. More recently, varenicline, also a non-nicotine medication, was approved for smoking cessation and has been shown to as much as triple rates of cessation compared with placebo. As a result, treatment providers are encouraged to recommend medications to patients willing to make a quit attempt (Fiore et al., 2008). In addition, combining medications with counseling and other behavioral treatments has been demonstrated to have better results than either approach alone (Fiore et al., 2008). Early evidence suggests that the same may be true of combining some medications (e.g., long-term nicotine patch plus other NRT (gum or spray); Fiore et al., 2008), although more research is likely needed to fully explore this area.

2.7.2. Application and extension to pregnant smokers—The use of medications to promote smoking cessation during pregnancy remains a controversial topic and pharmaceutical aids proven safe and effective in the general population are not yet routinely recommended for pregnant women in the U.S., although they are in several European countries that tend to have more liberal pharmacotherapy policies generally (e.g., Britain and France; Shiffman et al., 2008). The evidence that cessation medications increase abstinence rates in pregnant smokers is inconclusive (Fiore et al., 2008). Some of the ambiguity stems at least in part from the low rates of adherence with cessation medication regimens in studies to date (e.g., Fish et al., 2009). With regard to pregnant smokers, reports from randomized clinical trials of smoking cessation medications report average durations of medication use lasting 3 weeks or less (e.g., Pollak et al., 2007; Wisborg et al., 2000). For comparison, the 2008 Clinical Practice Guidelines recommend use of medication for at least 6–12 weeks in non-pregnant smokers and note that shorter durations of use may reduce their effectiveness (Fiore et al., 2008). Low adherence with prescribed medications has been recognized as a potential bias in the assessment of the efficacy of other medications (Haynes, 1979; Haynes and Dantes, 1987) and additional research

to better understand and manage non-adherence may be needed to help obtain sufficient safety and efficacy data to determine the place of pharmacotherapies in the treatment of smoking cessation during pregnancy. Certainly pharmacotherapies offer a potentially important treatment strategy for improving outcomes with pregnant smokers. As was suggested above regarding combining different efficacious behavioral interventions, combining efficacious behavioral interventions with pharmacotherapy also merits investigation among pregnant smokers. Perhaps a more remote possibility, but also worth considering, is the possibility of combining pharmacotherapies.

2.8. NIDA Principle #9: Many drug-addicted individuals also have other mental disorders

2.8.1. Empirical evidence from the broader literature on treatment of SUDs—

Depression, bipolar disorders, and other mood disorders, for example, are among the most common psychiatric co-morbidities among patients with SUDs (see Jane-Llopis & Matytsina, 2006). Mood and substance use disorder co-morbidity are associated with poorer treatment outcome (e.g., Hasin et al., 2002; Keller, 1986) and researchers and clinicians have begun to develop treatment approaches that address both disorders simultaneously. A recent meta-analysis of five trials examining the efficacy of integrated treatments for SUDs and co-morbid depression had positive results, favoring integrated treatment over treatment for SUDs alone on percent days abstinent (Hesse, 2009). Further examination of integrated treatments for SUDs and co-morbid mood disorders and possible extension of this approach to other mental disorders (e.g., anxiety disorders) will be important, providing another potential treatment option for the large number of patients with SUDs and co-occurring mental disorders.

2.8.2. Application and extension to pregnant smokers—Like with other SUDs, several studies report a positive relationship between depressive symptoms and smoking during pregnancy (e.g., Hanna et al., 1994), although the literature is mixed on whether depression is an independent predictor of smoking in pregnancy (e.g., Linares Scott, in press; Ludman et al., 2000). In a recent study addressing this issue, psychiatric symptoms (i.e., stress ratings, depressive symptoms, and reporting a history of depression) at treatment intake were considered along with demographics and smoking characteristics as potential predictors of smoking status at treatment entry, end of pregnancy, and six-months postpartum (Higgins et al., in press-a). Higher stress ratings were associated with decreased odds of being abstinent at prenatal care entry. Among women abstinent when entering prenatal care (i.e., spontaneous quitters), higher stress ratings were also associated with decreased odds of being abstinent at six-months postpartum. Overall, self-reported stress levels were significant predictors, especially in analyses conducted with spontaneous quitters, which is consistent with knowledge about predictors in that population from prior studies (Solomon & Quinn, 2004). These results suggest that interventions that include components to address co-occurring mental health problems may improve abstinence rates and reduce relapse rates among pregnant smokers.

2.9. NIDA Principle #11: Treatment does not need to be voluntary to be effective

2.9.1. Empirical evidence from the broader literature on treatment of SUDs—

Socially sanctioned mechanisms of coercion can be effective in initiating entry into treatment and achieving positive outcomes with individuals with other SUDs (see Nace et al., 2007). Civil commitment is an increasingly utilized form of coercion. Most laws stipulate that danger to self or others due to mental illness, including addictions, be the criteria upon which an individual may be committed. “Commitment” tends to bring to mind involuntary placement in inpatient mental hospitals, but in recent years, civil commitment efforts have more often focused on compulsory outpatient SUDs treatment (Nace et al., 2007). Balancing the rights of the individual with those of society remains a difficult issue that will continue to influence the acceptability and use of involuntary treatment mechanisms.

2.9.2. Application and extension to pregnant smokers—While adverse effects of smoking during pregnancy have been clearly demonstrated, it seems likely that the potential harm caused by inadvertent effects of coercive policies, such as unintentionally encouraging a delay or avoidance of prenatal care, may significantly outweigh any potential benefits of extending this approach to the treatment of pregnant smokers (Poland et al., 1993; U.S. General Accounting Office, 1990). In addition, research has demonstrated that pregnant smokers can and do respond to treatment. Developing and disseminating a more comprehensive array of treatment interventions as opposed to adopting coercive strategies seems like a more fruitful path to pursue with pregnant smokers.

2.10. NIDA Principle #12: Drug use during treatment must be monitored continuously, as lapses during treatment do occur

2.10.1. Empirical evidence from the broader literature on treatment of SUDs—Research suggests that there are conditions under which the accuracy of self-reported substance use is high (see Del Boca & Noll, 2000). However, in instances where perceived consequences of responding may influence personal outcomes (e.g., take home doses, treatment progress, compliance with legal mandates, etc.), the accuracy of self-report is often compromised (Chermack et al., 2000; Sherman & Bigelow, 1992). Indeed, objective monitoring keeps all interested parties, especially treatment providers, regularly apprised of the ups and downs in patients' efforts to resolve their drug abuse problem. Objective monitoring of drug use has become a standard of care among those dependent on illicit drugs: 82% of nearly 14,000 U.S. drug abuse treatment facilities report that they perform some level of drug or alcohol screening (Substance Abuse and Mental Health Services Administration, 2006). Ultimately the frequency of testing will depend on many factors, including but not limited to the patient population, local patterns of drug use, the types of drug testing used, the type of treatment provided, and the availability of staff and other treatment facility resources (e.g., Dunn et al., 2008).

2.10.2. Application and extension to pregnant smokers—Considering the well-known adverse health effects of smoking and growing cultural expectations that pregnant women will refrain from smoking, social demand characteristics clearly influence the accuracy of self-reported smoking status among pregnant women (see Russell et al., 2004; SRNT Subcommittee on Biochemical Verification, 2002). At least one study investigating self-reported smoking status among pregnant women demonstrated that use of a multiple-choice question format that allows women who are still smoking to report progress in cutting down improves disclosure of continued smoking by 40% over usual yes-no response questions about smoking status (Mullen et al., 1991). While such careful formatting can improve self-reported disclosure rates, there is little debate regarding the need for biochemical verification of smoking status in this population (Russell et al., 2004). Because pregnancy increases metabolism of nicotine and its metabolites (Dempsey et al., 2002), greater systematic information is needed regarding appropriate tests and cutpoints for doing so (SRNT Subcommittee on Biochemical Verification, 2002). At least one recent study examined several different methods and cutpoints for determining smoking status in pregnant and recently postpartum women (Higgins et al., 2007). Self-reported smoking status, urine-cotinine levels determined by gas chromatography (GC) and by enzyme immunoassay testing (EMIT), and breath carbon-monoxide (CO) levels were assessed in women enrolled in studies on smoking cessation and relapse prevention. Classifications based on urine-cotinine GC testing served as the standard in most analyses. Overall agreement between self-reported smoking status and classification based on urine-cotinine GC testing was highest at a 25 ng/ml cutpoint. Classifications based on EMIT urine-cotinine levels were in nearly perfect agreement with those made by GC when the cutpoint for the former was set at approximately 80 ng/ml. Classifications based on breath CO were in relatively poor agreement with GC classifications at all cutpoints examined, but best at 4 ppm.

Overall, there is a need for ongoing and systematic monitoring of smoking status while treating pregnant smokers.

3. Conclusions

In this brief review we examined whether pregnant smokers are similar enough to those with other types of SUDs that efficacious treatment approaches might generalize from one population to the other and whether principles of effective treatment of other SUDs might have generality to the treatment of smoking during pregnancy. Regarding similarities across populations, the results suggest a great deal of similarity and promise for generality. Across populations, most were young, unmarried, and had less than a high school education. Many were without full-time employment and private health insurance, and had incomes that fell below the federal poverty line, all indicative of lower SES status. These characteristics predict poor treatment outcome among those with SUDs and will have to be considered carefully in efforts to develop effective treatments for smoking during pregnancy.

Regarding generality of the principles of efficacious treatment for other types of SUDs to pregnant smokers, we were able to find instances where most principles had been applied to the treatment of smoking during pregnancy in some manner. Further, the application often resulted in positive outcomes. Such concordance is reassuring and suggests that the fields addressing other types of SUDs and smoking cessation during pregnancy are not as different as is often assumed. Unfortunately, in many cases we could find only a single report of a principle's application to smoking during pregnancy. Thus, there is generally not sufficient evidence at this time to adequately assess how well various principles of treatment for other SUDs apply to pregnant smokers. Fortunately, this lack of evidence represents a valuable opportunity for researchers and clinicians to investigate potential generality to pregnant smokers. For example, examining the efficacy of treatment matching among women who continue to smoke after entering prenatal care appears promising. The field is already tailoring treatments for early quitters versus those who continue smoking during pregnancy. Exploring more intensive and comprehensive treatments for continuing smokers with greater dependence appears to be an important step to explore as well. Ensuring that treatment is readily available and that early treatment response is closely monitored for signs of early success or failure are other examples of promising research topics to pursue. Considering the limited duration of pregnancy, facilitating treatment entry and rapid modifications in the treatment approach after a failed quit attempt will maximize the likelihood of cessation success by the end of the pregnancy. Exploring treatment combinations including pharmacotherapies and especially combined behavioral and pharmacological interventions are still other examples of potentially promising paths to explore with pregnant smokers. Of course, the importance of using objective measures to verify smoking status in all such efforts is essential so that the success of various treatments can be assessed in a fair and unbiased manner. Overall, we see much promise for enhancing treatment outcomes for pregnant smokers by borrowing from and extending what has been learned with other populations with SUDs.

Acknowledgments

Portions of this paper were presented at the CPDD Mini-conference, "Woman and Smoking: Understanding Socioeconomic Influences," April 9 & 10, Annapolis, MD.

References

- The American College of Obstetricians and Gynecologists. Guidelines for diagnostic imaging during pregnancy. *Obstet Gynecol* 2004;104:647–651. [PubMed: 15339791]
- Ardila A, Rosselli M, Strumwasser S. Neuropsychological deficits in chronic cocaine abusers. *Int J Neurosci* 1991;57:73–79. [PubMed: 1938157]

- Ball, JC.; Ross, A. The Effectiveness of Methadone Maintenance Treatment. New York: Springer-Verlag; 1991.
- Beatty WW, Katzung VM, Moreland VJ, Nixon SJ. Neuropsychological performance of recently abstinence alcoholics and cocaine abusers. *Drug Alcohol Depend* 1995;37:247–253. [PubMed: 7796719]
- Belizan JM, Barros F, Langer A, Farnot U, Victoria C, Villar J. the Latin American Network for Perinatal and Reproductive Research. Impact of health education during pregnancy on behavior and utilization of health resources. *Am J Obstet Gynecol* 1995;173:894–899. [PubMed: 7573265]
- Carise D, Gurel O, McLellan AT, Dugosh K, Kendig C. Getting patients the services they need using a computer-assisted system for patient assessment and referral-CASPAR. *Drug Alcohol Depend* 2005;80:177–189. [PubMed: 15913922]
- Carroll KM, Onken LS. Behavioral therapies for drug abuse. *Am J Psychiatry* 2005;162:1452–1460. [PubMed: 16055766]
- Carroll KM, Rounsaville BJ, Gawin FH. A comparative trial of psychotherapies for ambulatory cocaine abusers: Relapse prevention and interpersonal psychotherapy. *Am J Drug Alcohol Abuse* 1991;17:229–247. [PubMed: 1928019]
- Chermack ST, Roll J, Reilly M, Davis L, Kilaru U, Grabowski J. Comparison of patient self-reports and urinalysis results obtained under naturalistic methadone treatment conditions. *Drug Alcohol Depend* 2000;59:43–49. [PubMed: 10706974]
- Cnattingius S. The epidemiology of smoking during pregnancy: Smoking prevalence, maternal characteristics, and pregnancy outcomes. *Nicotine Tob Res* 2004;6:S125–S140. [PubMed: 15203816]
- Condelli WS, Hubbard RL. Relationship between time spent in treatment and client outcomes from therapeutic communities. *J Subst Abuse Treat* 1994;11:25–33. [PubMed: 8201630]
- Del Boca FK, Noll JA. Truth or consequences: The validity of self-report data in health services research on addictions. *Addiction* 2000;95:S347–S360. [PubMed: 11132362]
- Dempsey D, Jacob P, Benowitz NL. Accelerated metabolism of nicotine and cotinine in pregnant smokers. *J Pharmacol Exp Ther* 2002;301:594–598. [PubMed: 11961061]
- Donatelle RJ, Prows SL, Champeau D, Hudson D. Randomised controlled trial using social support and financial incentives for high risk pregnant smokers: Significant other supporter (SOS) program. *Tob Control* 2000;9:iii67–iii69. [PubMed: 10982912]
- Dunn KE, Sigmon SC, McGee MR, Heil SH, Higgins ST. Evaluation of ongoing oxycodone abuse among methadone-maintained patients. *J Subst Abuse Treat* 2008;35:451–456. [PubMed: 18295434]
- Dutra L, Stathopoulou G, Basden SL, Leyro TM, Powers MB, Otto MW. A meta-analytic review of psychosocial interventions for substance use disorders. *Am J Psychiatry* 2008;165:179–187. [PubMed: 18198270]
- Ebrahim SH, Decoufle P, Palakathodi AS. Combined tobacco and alcohol use by pregnant and reproductive-aged women in the United States. *Obstet Gynecol* 2000;96:767–771. [PubMed: 11042316]
- Ershoff DH, Hall Ashford T, Goldenberg RL. Helping pregnant women quit smoking: An overview. *Nicotine Tob Res* 2004;6:S101–S105. [PubMed: 15203814]
- Festinger DS, Lamb RJ, Kountz MR, Kirby KC, Marlowe D. Pretreatment dropout as a function of treatment delay and client variables. *Addict Behav* 1995;20:111–115. [PubMed: 7785476]
- Festinger DS, Lamb RJ, Marlowe DB, Kirby KC. From telephone to office: Intake attendance as a function of appointment delay. *Addict Behav* 2002;20:111–115. [PubMed: 7785476]
- Fingerhut LA, Kleinman JC, Kendrick JS. Smoking before, during, and after pregnancy. *Am J Public Health* 1990;80:541–544. [PubMed: 2327529]
- Fiore, MC.; Jaen, CR.; Baker, TB.; Bailey, WC.; Benowitz, NL.; Curry, SJ., et al. Treating tobacco use and dependence: 2008 update. U.S. Department of Health and Human Services, Public Health Service; Rockville, MD: 2008. p. 257
- Fish LJ, Peterson BL, Namenek Brower RJ, Lyna P, Oncken CA, Swamy GK, Myers ER, Pletsch PK, Pollak KI. Adherence to nicotine replacement therapy among pregnant smokers. *Nicotine Tob Res* 2009;11:514–518. [PubMed: 19351783]

- Garavan H, Hester R. The role of cognitive control in cocaine dependence. *Neuropsychol Rev* 2007;17:337–345. [PubMed: 17680368]
- Hanna EZ, Faden VB, Dufour MC. The motivational correlates of drinking, smoking, and illicit drug use during pregnancy. *J Subst Abuse* 1994;6:155–167. [PubMed: 7804015]
- Hasin D, Liu X, Nunes E, McCloud S, Samet S, Endicott J. Effects of major depression on remission and relapse of substance dependence. *Arch Gen Psychiatry* 2002;59:375–380. [PubMed: 11926938]
- Haynes, RB. Determinants of compliance: The disease and the mechanics of treatment. In: Haynes, RB.; Taylor, DW.; Sackett, DL., editors. *Compliance in health care*. Johns Hopkins University Press; Baltimore: 1979. p. 49-62.
- Haynes RB, Dantes R. Patient compliance in the design and interpretation of clinical trials. *Control Clin Trials* 1987;8:12–19. [PubMed: 3568692]
- Heil SH, Higgins ST, Bernstein IM, Solomon LJ, Thomas CS, Badger GJ, Lynch ME. Effects of voucher-based incentives on abstinence from cigarette smoking and fetal growth among pregnant women. *Addiction* 2008;109:1009–1018. [PubMed: 18482424]
- Hesse M. Integrated psychological treatment for substance use and co-morbid anxiety or depression vs. treatment for substance use alone. A systematic review of the published literature. *BMC Psychiatry* 2009;9:6. [PubMed: 19232121]
- Hester R, Garavan H. Executive dysfunction in cocaine addiction: Evidence for discordant frontal, cingulate and cerebellar activity. *J Neurosci* 2004;24:11017–11022. [PubMed: 15590917]
- Higgins ST, Badger GJ, Budney AJ. Initial abstinence and success in achieving longer term cocaine abstinence. *Exp Clin Psychopharmacol* 2000;8:377–386. [PubMed: 10975629]
- Higgins ST, Heil SH, Badger GJ, Mongeon JA, Solomon LJ, McHale L, Bernstein IM. Biochemical verification of smoking status in pregnant and recently postpartum women. *Exp Clin Psychopharmacol* 2007;15:58–66. [PubMed: 17295585]
- Higgins ST, Heil SH, Badger GJ, Skelly JM, Solomon LJ, Bernstein IM. Educational disadvantage and cigarette smoking during pregnancy. *Drug Alcohol Depend.* 2009in press this issue
- Higgins ST, Heil SH, Dumeer AM, Thomas CS, Solomon LJ, Bernstein IM. Smoking status in the initial weeks of quitting as a predictor of smoking-cessation outcomes in pregnant smokers. *Drug Alcohol Depend* 2006;85:138–141. [PubMed: 16720082]
- Higgins, ST.; Heil, SH.; Rogers, RE.; Chivers, L. Cocaine. In: Higgins, ST.; Silverman, K.; Heil, SH., editors. *Contingency management in the treatment of substance use disorders: A science-based treatment innovation*. Guilford Press; New York: 2008. p. 19-41.
- Higgins ST, Heil SH, Solomon LJ, Bernstein IM, Lussier JP, Abel RL, Lynch ME, Badger GJ. A pilot study on voucher-based incentives to promote abstinence from cigarettes smoking during pregnancy and post-partum. *Nicotine Tob Res* 2004;6:1015–1020. [PubMed: 15801574]
- Higgins ST, Heil SH, Solomon LJ, Bernstein IM, Rogers R. Contingency management to promote smoking cessation among pregnant women. *Nicotine Tob Res.* in press-b
- Hoffman KA, Ford JH, Choi D, Gustafson DH, McCarty D. Replication and sustainability of improved access and retention with the Network for the Improvement of Addiction Treatment. *Drug Alcohol Depend* 2008;98:63–69. [PubMed: 18565693]
- Hser YI, Polinsky ML, Maglione M, Anglin MD. Matching clients' needs with drug treatment services. *J Subst Abuse Treat* 1999;16:299–305. [PubMed: 10349602]
- Hughes JC, Cook CC. The efficacy of disulfiram: A review of outcome studies. *Addiction* 1997;92:381–395. [PubMed: 9177060]
- Huisman M, Kunst AE, Mackenbach JP. Intelligence and socioeconomic inequalities in health. *Lancet* 2005;366:807–808. [PubMed: 16139654]
- Jane-Llopis E, Matysina I. Mental health and alcohol, drugs and tobacco: A review of the comorbidity between mental disorders and the use of alcohol, tobacco and illicit drugs. *Drug Alcohol Rev* 2006;25:515–536. [PubMed: 17132571]
- Keller MB. The persistent risk of chronicity in recurrent episodes of nonbipolar major depressive disorder: A prospective follow-up. *Am J Psychiatry* 1986;143:24–28. [PubMed: 3942283]
- Kenford SL, Fiore MC, Jorenby DE, Smith SS, Wetter D, Baker TB. Predicting smoking cessation. Who will quit with and without the nicotine patch. *JAMA* 1994;271:589–594. [PubMed: 8301790]

- Kramer MS, Sequin L, Lydon J, Goulet L. Socio-economic disparities in pregnancy outcomes: Why do the poor fare so poorly? *Paediatr Perinat Epidemiol* 2000;14:194–210. [PubMed: 10949211]
- Krystal JH, Cramer JA, Krol WF, Kirk GF, Rosenheck RA. Veterans Affairs Naltrexone Cooperative Study 425 Group. Naltrexone in the treatment of alcohol dependence. *N Engl J Med* 2001;345:1734–1739. [PubMed: 11742047]
- Lieberman E, Gremy I, Lang JM, Cohen AP. Low birthweight at term and the timing of fetal exposure to maternal smoking. *Am J Public Health* 1994;84:1127–1131. [PubMed: 8017537]
- Linares Scott T, Heil SH, Higgins ST, Badger GJ, Bernstein IM. Depressive symptoms predict smoking status among pregnant women. *Addict Behav.* in press
- Ludman EJ, McBride CM, Nelson JC, Curry SJ, Grothaus LC, Lando HA, Pirie PL. Stress, depressive symptoms, and smoking cessation among pregnant women. *Health Psychol* 2000;19:21–27. [PubMed: 10711584]
- Lumley J, Oliver SS, Chamberlain C, Oakley L. Interventions for promoting smoking cessation during pregnancy. *Cochrane Database Syst Rev* 2004;4:1–88.
- MacArthur C, Knox EG. Smoking in pregnancy: Effects of stopping at different stages. *Br J Obstet Gynaecol* 1988;95:551–555. [PubMed: 3390400]
- Mathews TJ. Smoking during pregnancy, 1990–96. *Natl Vital Stat Rep* 1998;47:1–12.
- Mattick RP, Kimber J, Breen C, Davoli M. Buprenorphine maintenance versus placebo or methadone maintenance for opioid dependence. *Cochrane Database Syst Rev* 2008;16:CD002207. [PubMed: 18425880]
- McLellan AT, Alterman AI, Cacciola J, Metzger D, O'Brien CP. A new measure of substance abuse treatment: Initial studies of the Treatment Services Review. *J Nerv Ment Dis* 1992;180:101–110. [PubMed: 1737971]
- McLellan AT, Arndt IO, Metzger DS, Woody GE, O'Brien CP. The effects of psychosocial services in substance abuse treatment. *JAMA* 1993;269:1953–1959. [PubMed: 8385230]
- McLellan AT, Grissom GR, Zanis D, Randall M, Brill P, O'Brien CP. Problem-service 'matching' in addiction treatment: A prospective study in four programs. *Arch Gen Psychiatry* 1997;54:730–735. [PubMed: 9283508]
- Melvin CL, Gaffney CA. Treating nicotine use and dependence of pregnant and parenting smokers: An update. *Nicotine Tob Res* 2004;6:S107–S124. [PubMed: 15203815]
- Mullen PD. How can more smoking suspension during pregnancy become lifelong abstinence? Lessons learned about predictors, interventions, and gaps in our accumulated knowledge. *Nicotine Tob Res* 2004;6:S217–S238. [PubMed: 15203823]
- Mullen PD, Carbonari JP, Tabak ER, Glenday MC. Improving disclosure of smoking by pregnant women. *Am J Obstet Gynecol* 1991;165:409–413. [PubMed: 1872348]
- Nace EP, Birkmayer F, Sullivan MA, Galanter M, Fromson JA, Frances RJ, Levin FR, Lewis C, Suchinsky RT, Tamerin JS, Westermeyer J. Socially sanctioned coercion mechanisms for addiction treatment. *Am J Addict* 2007;16:15–23. [PubMed: 17364417]
- National Institute on Drug Abuse. Principles of drug addiction treatment: A research-based guide. Vol. 2. National Institutes of Health; Rockville, MD: 2009.
- Orleans CT, Barker DC, Kaufman NJ, Marx JF. Helping pregnant smokers quit: Meeting the challenge in the next decade. *Tob Control* 2000;9:iii6–iii11. [PubMed: 10982898]
- Poland ML, Dombrowski MP, Ager JW, Sokol RJ. Punishing pregnant drug users: Enhancing the flight from care. *Drug Alcohol Depend* 1993;31:199–203. [PubMed: 8462410]
- Pollak KI, Oncken CA, Lipkus IM, Lyna P, Swamy GK, Pletsch PK, Peterson BL, Heine RP, Brouwer RJ, Fish L, Myers ER. Nicotine replacement and behavioral therapy for smoking cessation in pregnancy. *Am J Prev Med* 2007;33:297–305. [PubMed: 17888856]
- Preston KL, Silverman K, Higgins ST, Brooner RK, Montoya I, Schuster CR, Cone EJ. Cocaine use early in treatment predicts outcome in a behavioral treatment program. *J Consult Clin Psychol* 1998;66:691–696. [PubMed: 9735588]
- Project MATCH Research Group. Matching alcoholism treatments to client heterogeneity: Project MATCH posttreatment drinking outcomes. *J Stud Alcohol* 1997;58:7–29. [PubMed: 8979210]

- Ruger JP, Weinstein MC, Hammond SK, Kearney MH, Emmons KM. Cost-effectiveness of motivational interviewing for smoking cessation and relapse prevention among low-income pregnant women: A randomized controlled trial. *Val Health* 2008;11:191–198.
- Russell T, Crawford M, Woodby L. Measurements for active cigarette smoke exposure in prevalence and cessation studies: Why simply asking pregnant women isn't enough. *Nicotine Tob Res* 2004;6:S141–S151. [PubMed: 15203817]
- Sexton M, Hebel JR. A clinical trial of change in maternal smoking and its effect on birth weight. *JAMA* 1984;251:911–915. [PubMed: 6363731]
- Sherman MF, Bigelow GE. Validity of patients' self-reported drug use as a function of treatment status. *Drug Alcohol Depend* 1992;30:1–11. [PubMed: 1317286]
- Shiffman S, Sweeney CT. Ten years after the Rx-to-OTC switch of nicotine replacement therapy: What have we learned about the benefits and risks of non-prescription availability? *Health Policy* 2008;86:17–26. [PubMed: 17935827]
- Silverman K, Chutuaape MA, Bigelow GE, Stitzer ML. Voucher-based reinforcement of cocaine abstinence in treatment-resistant methadone patients: Effects of reinforcement magnitude. *Psychopharmacology (Berl)* 1999;146:128–138. [PubMed: 10525747]
- Simpson DD. National treatment system evaluation based on the Drug Abuse Reporting Program (DARP) followup research. *NIDA Res Monogr* 1984;51:29–41. [PubMed: 6438517]
- Simpson DD, Joe GW, Rowan-Szal GA, Greener JM. Drug abuse treatment process components that improve retention. *J Subst Abuse Treat* 1997;14:565–572. [PubMed: 9437628]
- Slotkin TA. Fetal nicotine or cocaine exposure: Which one is worse. *J Pharmacol Exp Ther* 1998;285:931–945. [PubMed: 9618392]
- Slotkin TA. If nicotine is a developmental neurotoxicant in animal studies, dare we recommend nicotine replacement therapy in pregnant women and adolescents? *Neurotoxicol Teratol* 2008;30:1–19. [PubMed: 18380035]
- Solomon LJ, Quinn VP. Spontaneous quitting: Self-initiated smoking cessation in early pregnancy. *Nicotine Tob Res* 2004;6:S203–S216. [PubMed: 15203822]
- SRNT Subcommittee on Biochemical Verification. Biochemical verification of tobacco use and cessation. *Nicotine Tob Res* 2002;4:149–159. [PubMed: 12028847]
- Stark MJ, Campbell BK, Brinkerhoff CV. "Hello, may we help you?" A study of attrition prevention at the time of the first phone contact with substance-abusing clients. *Am J Drug Alcohol Abuse* 1990;16:67–76. [PubMed: 2330937]
- Steenland K, Henley J, Thun M. All-cause and cause-specific death rates by educational status for two million people in two American Cancer Society cohorts, 1959–1996. *Am J Epidemiol* 2002;156:11–21. [PubMed: 12076884]
- Steenland K, Rodriguez C, Mondul A, Calle EE, Thun M. Prostate cancer incidence and survival in relation to education (United States). *Cancer Causes Control* 2004;15:939–945. [PubMed: 15577296]
- Substance Abuse and Mental Health Services Administration, Office of Applied Studies, 2006. National Survey of Substance Abuse Treatment Services (N-SSATS), Data on Substance Abuse Treatment Facilities, DASIS Series: S-39, DHHS Publication No. (SMA) 07-4296, Rockville, MD.
- Substance Abuse and Mental Health Services Administration, Office of Applied Studies, 2008. Results from the 2007 National Survey on Drug Use and Health: National Findings (NSDUH Series H-34, DHHS Publication No. SMA 08-4343). Rockville, MD.
- U.S. Department of Health and Human Services. Women and smoking: A report of the Surgeon General. U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General; Rockville, MD: 2001.
- U.S. General Accounting Office. US Senate. Washington, D.C: General Accounting Office; 1990. Drug exposed infants: A generation at risk: Report to the Chairman, Committee on Finance.
- Volkow ND, Fowler JS, Wang GJ, Swanson JM. Dopamine in drug abuse and addiction: Results from imaging studies and treatment implications. *Mol Psychiatry* 2004;9:557–569. [PubMed: 15098002]
- Volkow ND, Fowler JS, Wang GJ, Swanson JM, Telang F. Dopamine in drug abuse and addiction: Results of imaging studies and treatment implications. *Arch Neurol* 2007;64:1575–1579. [PubMed: 17998440]

- Volkow ND, Wang GJ, Fowler JS, Logan J, Gatley SJ, Hitzemann R, Chen AD, Dewey SL, Pappas N. Decreased striatal dopaminergic responsiveness in detoxified cocaine-dependent subjects. *Nature* 1997;386:830–833. [PubMed: 9126741]
- Walker R. Retention in treatment – indicator or illusion. *Subst Use Misuse* 2009;44:18–27. [PubMed: 19137480]
- Wisborg K, Henriksen TB, Jespersen LB, Secher NJ. Nicotine patches for pregnant smokers: A randomized controlled study. *Obstet Gynecol* 2000;96:967–971. [PubMed: 11084187]

Table 1

Socio-demographic Characteristics of Selected Populations Reporting Current Use of the Indicated Drug in the 2007 National Survey of Drug Use and Health

Characteristics	Pregnant Cigarette Smokers (N=390,478) [*]	Marijuana Users (N=13,972,186) [*]	Cocaine Users (N=2,161,129) [*]	Heroin Users (N=150,577) [*]
% ≤ 25 years old	59	49	32	33
% not married	75	79	86	76
% with ≤ 12 years of education	68	48	54	76
% without full-time employment	69	46	48	75
% without private health insurance	76	43	56	72
% with income below the federal poverty line	43	16	19	26

^{*} The N within each population varied across different socio-demographic characteristics. For ease of presentation, the largest N is presented for each population. The smallest N for each population was no more than 2% less than the largest.