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Association of post-treatment smoking change with future smoking and cessation efforts among adolescents with psychiatric comorbidity

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Abstract

Little is known about how initial change following a smoking intervention relates to longer-term smoking outcomes among adolescent smokers with psychiatric comorbidity. The present study investigated this relationship among psychiatrically hospitalized adolescents ($N=183$) who participated in a controlled trial comparing motivational interviewing to brief advice. Quit attempters ($n=37$), reducers ($n=45$), and maintainers ($n=101$) were assembled based on, respectively, having made a quit attempt, having reduced smoking by at least 50%, and having reduced smoking by less than 50% in the first week after hospital discharge. Hierarchical linear models and generalized estimating equations were conducted to test group differences in average number of cigarettes per smoking day and odds of making a quit attempt during subsequent weeks of a 12-month continuous follow-up, and in cotinine-verified abstinence rates at 1, 6, and 12 months posthospitalization. Baseline smoking levels and presence of a substance use disorder or anxiety disorder were predictive of outcomes. After controlling for covariates, we found that quit attempters smoked less during follow-up than did the other change groups and that reducers smoked less than maintainers. Quit attempters evidenced a higher percentage of quit attempts during follow-up than did the other change groups. Reducers had a greater average percentage of quit attempts during follow-up than did maintainers. However, groups did not differ on cotinine-verified abstinence rates across the follow-up period. Findings have implications for initial post-treatment change as it relates to subsequent smoking and cessation outcomes among adolescent smokers at especially high risk for smoking persistence.

Introduction

Cigarette smoking among adolescents remains a major public health concern given the frequent persistence of this behavior into adulthood, resulting in significant health risks. Although smoking prevalence rates among adolescents declined during the latter 1990s, this decline appears to be decelerating (Johnston, O'Malley, Bachman, & Schulenberg, 2005). Additionally, adolescent smoking is highly comorbid with psychiatric and substance use disorders (e.g., R. A. Brown, Lewinsohn, Seeley, & Wagner, 1996; Upadhyahya, Deas, Brady, & Kruesi, 2002), and adolescent smokers with psychiatric comorbidity may be especially at risk for persistence of smoking into adulthood (Myers & Brown, 1997; Rohde, Kahler, Lewinsohn, & Brown, 2004). Recognition of relatively stable smoking prevalence rates in this developmental group has led to increased interest in adolescent smoking cessation treatment (e.g., R. A. Brown et al., 2003; Dino et al., 2001; Mermelstein, 2003; Sussman, Dent, & Lichtman, 2001). However, few empirical data exist examining cessation processes (Killen et al., 2004) or intermediate outcomes toward cessation among adolescent smokers broadly and among those with psychiatric comorbidity in particular. Notably, how initial changes in smoking behavior (e.g., quit attempts, smoking reductions) subsequent to intervention relate to longer-term outcomes among adolescents is unknown (Backinger et al., 2003; Mermelstein, 2003). A better understanding of how and if such intermediate criteria predict subsequent smoking and cessation behaviors can inform intervention design.

Although adolescent smoking intervention studies are increasingly reporting intentional quit attempts as primary outcomes (e.g., Myers & Brown, 2005), how these postintervention change efforts relate to future smoking behavior and cessation efforts is unclear. An important conceptual distinction in examining smoking change efforts among adolescents is the difference between whether or not an attempt to quit has been made versus how long the quit attempt was sustained (S. A. Brown, 2001; Rose, Chassin, Presson, & Sherman, 1996). In a review of factors related to cessation among treated adult smokers, Ockene and colleagues (2000) identified both a greater number of and greater duration of past quit attempts as predictive of maintenance of cessation for at least 6 months across studies. Quit attempts subsequent to intervention may function in a number of ways in progress toward cessation for adolescents. For example, a quit attempt may disrupt an adolescent's typical smoking pattern, potentially leading to a subsequent lower smoking rate (e.g., Hughes, 2000); may diminish or slow progression to more established smoking patterns (Jamner et al., 2003); or may disrupt the development of nicotine dependence. Having attempted to quit may also represent a learning experience that motivates continued quit efforts (Carpenter & Hughes, 2005; Heil, Alessi, Lussier, Badger, & Higgins, 2004).

In the adult literature, considerable attention has been paid to interventions targeting smoking reductions as an alternative outcome to cessation (e.g., Hill, Weiss, Walker, & Jolley, 1988; Lamb, Morral, Galbicka, Kirby, & Iguchi, 2005) and to the effects of smoking reduction on future cessation efforts (e.g., Hughes, Cummings, & Hyland, 1999; Hyland et al., 2005). However, debate continues over the potential utility of reductions in smoking as intermediate steps toward cessation (Carpenter, Hughes, Solomon, & Callas, 2004; Hughes et al., 1999; Hyland et al., 2005; Shiffman et al., 2002). For example, one possibility is that reductions in smoking could detract from future cessation efforts by contributing to the reducers' beliefs that reduction is sufficient to ameliorate negative smoking-related consequences, thus eliminating the perceived necessity of cessation (Carpenter et al., 2004; Hyland et al., 2005). Alternatively, it has been argued that successful efforts to reduce smoking could decrease nicotine dependence and increase self-efficacy in one's ability to change smoking behavior (e.g., Bolliger et al., 2000; Carpenter et al., 2004; Hyland et al., 2005), increasing efforts toward or the success of cessation.

Yet these postintervention processes have received little attention in adolescent smokers. In particular, not much is known about whether postintervention quit attempts or smoking reductions relate to continued or future cessation efforts (e.g., further smoking reductions, quit attempts, abstinence rates) among adolescents. Examination of initial smoking reductions and quit attempts may shed additional light on how the process of adolescent smoking cessation unfolds following intervention (Mermelstein, 2003). This is especially important given that adolescent smoking intervention studies frequently report smoking reductions as primary outcomes (Sussman, 2002), and abstinence rates across a variety of adolescent samples receiving smoking interventions (e.g., those admitted to an emergency room, those with comorbid substance use disorders, and those who are heavy daily smokers) are unfortunately low (e.g., Colby et al., 2005; Moolchan et al., 2005; Myers & Brown, 2005).

The present study investigated how initial change following an intervention relates to longer-term smoking outcomes among psychiatrically hospitalized adolescents who participated in a controlled trial of motivational interviewing (MI) vs. brief advice (BA; R. A. Brown et al., 2003). Although this study did not demonstrate differential treatment effects, the randomized trial format enables us to look at changes in smoking behavior as participants were restricted from smoking while hospitalized and many attempted to change their smoking immediately after treatment. Specifically, we were interested in whether adolescent smokers making a quit attempt in the first week following hospitalization (quit attempters) evidenced lower rates of smoking, greater likelihood of attempting to quit, and higher abstinence rates over the subsequent year, compared with other smokers in the study. Additionally, we examined smoking reductions in the first week posthospitalization in relation to these smoking, quit attempt, and abstinence outcomes. As no studies to date have examined the predictive utility of immediate reduction following treatment among adolescent smokers, we divided participants based on criteria commonly used in the adult literature (e.g., Hyland et al., 2005): (a) those who had reduced smoking by 50% or more (reducers) and (b) those who had reduced their smoking by less than 50% (maintainers) from the 3 months prehospitalization. We expected that adolescent smokers who reduced by 50% or more would evidence lower rates of smoking, greater likelihood of quit attempts, and better abstinence outcomes over the subsequent year, compared with those who had reduced by less than 50%.

Method

Procedure

This study used data from a sample of 13- to 17-year-old adolescent smokers hospitalized for psychiatric and substance use disorders ($N=191$) who participated in a randomized control trial comparing MI to BA for smoking cessation. Study methods and procedures were reported previously (R. A. Brown et al., 2003). Criteria for subject inclusion in the original study were (a) being aged 13–17 years, (b) having smoked at least one cigarette per week for the 4 weeks before hospitalization, and (c) having access to a telephone. Adolescents were excluded from the study for the following reasons: recent violent behavior ($n=46$), presence of a current psychotic disorder ($n=58$), current participation in another study ($n=28$), uncertain guardianship status ($n=21$), language incompatibility ($n=16$), having a sibling in the study ($n=11$), having significant cognitive impairment ($n=7$), residing too far away to complete follow-up assessments ($n=6$), or having hearing impairment ($n=4$). Please see R. A. Brown et al. (2003) for specific details regarding participant screening and recruitment flow in the original randomized control trial. Informed consent (assent for minors) was obtained from parents or legal guardians and adolescent participants. Participants were assigned by cohort to treatment condition (MI vs. BA; see R. A. Brown et al., 2003, for intervention descriptions). Data were collected through a combination of structured interviews and self-report questionnaires at baseline prior to the intervention; immediately posthospitalization; and at 1-,

3-, 6-, 9-, and 12-month follow-ups. The 3- and 9-month follow-ups were limited to telephone administration of a smoking time-line follow-back interview. Seven-day point prevalence abstinence was verified at 1-, 6-, and 12-month follow-ups with salivary cotinine using a cut-off of 15 ng/ml and expired carbon monoxide using a cut-off of less than 10 ppm. Follow-ups were completed with 94%, 95%, 92%, 93%, and 91% of participants at the 1-, 3-, 6-, 9-, and 12-month follow-ups, respectively.

Included in the present study were 183 adolescents for whom posthospitalization smoking data were available for at least 4 weeks, although the vast majority (92%) had valid data for more than 75% of the weeks in the year. Participants were excluded from analyses because of having less than 4 weeks of valid posthospitalization smoking data available ($n=6$), missing all baseline health questionnaire data ($n=1$), or missing all psychiatric diagnostic information ($n=1$). The included participants were on average 15.8 years of age ($SD=1.7$); 63% ($n=116$) were female, and 94.5% were White.

Measures

Time-line follow-back (TLFB)—TLFB (Sobell & Sobell, 1992) was used to gather information regarding number of cigarettes smoked, number of standard alcohol drinks consumed, and classes of illicit substances used for each of the 90 days preceding hospitalization, and at each follow-up going back to the point of the last study interview. Information was collected using a calendar format to provide temporal cues (e.g., holidays) to assist in recall. TLFB at follow-ups assessed use of cigarettes and self-reports of quit attempts since the previous assessment. Weekly averages for cigarette use per smoking day and self-reports of quit attempts were computed using days when participants were not in an environment that restricted smoking behavior. TLFB has been shown to have good reliability and validity with adult (R. A. Brown et al., 1998) and adolescent smokers (Lewis-Esquerre et al., 2005).

Modified Fagerström Tolerance Questionnaire (mFTQ)—Nicotine dependence was assessed using the 7-item mFTQ questionnaire revised for adolescents (Prokhorov, Koehly, Pallonen, & Hudmon, 1998; Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996). Level of nicotine dependence was evaluated based on the following mFTQ cut-offs: ≤ 2 , no nicotine dependence; >2 to ≤ 5 , moderate dependence; and >5 , substantial dependence (Prokhorov et al., 2001).

Columbia-Diagnostic Interview Schedule for Children (C-DISC)—The C-DISC was used to determine the psychiatric diagnostic status of study participants. The C-DISC is a reliable and valid structured interview (Costello, Edelbrock, Duncan, Kalas, & Klaric, 1984; Weinstein, Noam, Grimes, Stone, & Schwab-Stone, 1990) that assesses *DSM-IV* psychiatric diagnoses for children and adolescents.

Intention to change smoking behaviour—Intentions to change smoking behavior upon leaving the hospital were assessed at end of treatment using a 5-point Likert-type scale with responses ranging from planning to “smoke more than I used to” (1) to planning to “quit smoking completely” (5). Because of low frequencies of some responses, responses to this item were categorized as “smoke same,” “smoke less,” and “quit.”

Data analyses

Participants were categorized into three smoking change groups based on change between smoking behavior during the 90 days prior to hospitalization and smoking during the first week posthospitalization. As a portion of adolescents (10%) entered a restricted environment (e.g., hospital or treatment facility where they were not allowed to smoke) immediately

posthospitalization, those participants were categorized based on changes in smoking behavior during the first week living in an unrestricted environment. The three change groups were (a) quit attempters ($n=37$), defined as those who attempted to quit (as evidenced by self-report of a volitional quit attempt of at least 24 hr) in the first week posthospitalization/restricted environment; (b) reducers ($n=45$), defined as those who reduced their smoking by 50% or more between 90 days prehospitalization and the first week posthospitalization/restricted environment and who did not report a volitional quit attempt during that first week; and (c) maintainers ($n=101$), defined as those who reduced their smoking by less than 50% or maintained their smoking patterns from 90 days prehospitalization to the first week posthospitalization/restricted environment.

Although quit attempters, reducers, and maintainers groups are conceptualized as mutually exclusive, 35% ($n=13$) of quit attempters also exhibited some smoking either just prior to or immediately following their quit attempt in the first week posthospitalization. We assigned these 13 smokers to the quit attempter group because, unlike others categorized as reducers or maintainers, these individuals reported a volitional attempt at smoking cessation during that week. Further, although use of percent change (e.g., reduced smoking level by 50% or more) has been a common metric by which to operationalize smoking reduction in the adult literature (e.g., Etter, Laszlo, Zellweger, Perrot, & Perneger, 2002; Hughes, 1999; Hyland et al., 2005), there is currently no gold standard for how best to measure smoking change among adolescents. Findings that reductions of 50% or greater in the adult literature are predictive of cessation outcomes support the potential clinical utility of this approach to measure change (Hughes, 1999; Hyland et al., 2005). Disadvantages of this approach include the arbitrariness of 50% as a cut-off and the possibility that heavier smokers are over-represented in certain reduction groups (e.g., reducers; Hughes & Carpenter, 2005). We believed the advantages outweighed the disadvantages of using percent reduction in this initial examination among adolescent smokers of postintervention change as it relates to smoking and quit outcomes. Our decisions resulted in groups in which the median percentage change was a 74.1% reduction for reducers and a 19.5% increase for maintainers. The median reduction in number of cigarettes was 10.8 cigarettes per smoking day for reducers 0.71 cigarettes per smoking day and for maintainers.

Hierarchical linear modeling (HLM) and generalized estimating equations (GEEs) were conducted to test group differences in (a) the average number of cigarettes smoked per smoking day during each week of follow-up subsequent to the first week posthospitalization/restricted environment, (b) the odds of making a quit attempt during each week of follow-up subsequent to the first week posthospitalization/restricted environment, and (c) the odds of being abstinent at 1-, 6-, and 12-months posthospitalization. In these analyses, we examined demographics (age and gender), diagnostic categories, treatment condition, and intention to quit posthospitalization as covariates. The only baseline variables that were related to outcomes were age, the number of cigarettes smoked per smoking day, intentions to quit posthospitalization, and presence of an anxiety or substance use disorder (R. A. Brown et al., 2003). We included only these covariates in our analyses. We also covaried for treatment condition given the design and purposes of the original study.

Results

Sample characteristics

Smoking change groups were compared across demographics and covariates (Table 1). Adolescents in the three groups did not differ significantly by treatment condition, age, sex, nicotine dependence, or cigarettes per smoking day in the 90 days prehospitalization. Based on results of the C-DISC, psychiatric diagnoses were collapsed into four groups: anxiety disorders ($n=103$), mood disorders ($n=83$), substance use disorders ($n=130$), and disruptive behavioral disorders ($n=145$). Smoking change groups did not differ across diagnostic

categories (p values $>.15$). We found no significant differences in the number of diagnostic categories met across quit attempters ($M=2.5$, $SD=1.2$), reducers ($M=2.6$, $SD=1.0$), or maintainers ($M=2.4$, $SD=1.2$; $p=.61$).

In the present sample, initiation of smoking occurred at a mean age of 11.2 years with progression to weekly smoking by age 12.6 years. During the 3 months prior to hospitalization, 58.5% of participants were daily smokers and smoked an average of 14.3 cigarettes ($SD=9.49$) on smoking days. In addition, 58% reported having attempted to quit in their lifetime, with 48% reporting a quit attempt within the past year. Level of nicotine dependence as assessed by the mFTQ was in the moderate range ($M=4.9$, $SD=1.8$). We also found a trend for reducers to have a greater proportion of daily smokers (73.3%) than quit attempters (48.6%) and maintainers (55.4%); $\chi^2(2)=6.43$, $p=.051$. Thus the present sample included relatively established and regular smokers who had developed moderate symptoms of dependence. As shown in Table 1, 64.9% of quit attempters reported intention to quit at end of treatment compared with 17.8% of reducers and 19.8% of maintainers; $\chi^2(4)=32.24$, $p=.0001$. Finally, we found no significant treatment condition (MI vs. BA) by smoking change group differences across demographics, covariates, and smoking history variables (results not reported).

Posthospitalization smoking patterns

Figure 1 presents weekly averages of cigarettes smoked per smoking day across the follow-up period for each of the smoking change groups. Smoking rates in the quit attempters during follow-up ranged from a low of 2.2 ($SD=5.0$) cigarettes per smoking day in week 1 following the quit attempt to a high of 9.2 ($SD=9.6$) during week 29. Among the reducers, smoking rates evidenced more modest variability with a low of 5.0 ($SD=4.6$) in week 1 following the initial reduction to a high of 10.2 ($SD=8.6$) during week 43. In contrast, among maintainers, smoking rates were at a low of 8.5 ($SD=8.2$) cigarettes per smoking day in week 50 to a high of 12.7 ($SD=9.9$) in week 1. Overall, quit attempters exhibited a rapid increase in smoking rate during the first 12 weeks, after which patterns fluctuated, whereas reducers increased their smoking rates modestly over time and maintainers evidenced a slight decrease in smoking across the follow-up period. Thus adolescents who made changes immediately posthospitalization/restricted environment tended to increase their smoking level over time although to an overall reduced level as compared with the 90 days prior to hospitalization.

HLM was used to examine group differences in smoking rates over the follow-up period. In all models, age, treatment condition, cigarettes smoked per smoking day, presence of anxiety disorder and substance use disorder, and posthospitalization intentions to quit were included as covariates along with the main effect of smoking change groups and the centered linear effect of time. Follow-up models also evaluated the centered quadratic effect of time. The models included a random intercept and random slope when evaluating either the linear or quadratic effects of time. Reduction in Schwarz's Bayesian information criterion (BIC) indicated that individual growth trajectories were best modeled using both linear and quadratic slope terms. Two orthogonal contrasts were created to capture the effects of smoking change groups: (a) quit attempters vs. all other groups, and (b) reducers vs. maintainers. The model was analyzed with all main effects contrasts for change groups in one block with the linear and quadratic effects of time. The main effect estimates for change group differences are reported from the model prior to inclusion of any interaction terms. Evaluation of main effects was followed by models that included interactions of change group with the linear time and the quadratic time effects in the final block. We report estimates of significant change group by linear time interactions using models after removing any nonsignificant quadratic time interactions.

Consistent with previous reports with this sample (R. A. Brown et al., 2003), we found no significant difference between the treatment conditions in weekly number of cigarettes smoked

per smoking day across the follow-up period ($B=.45$, $SE=.72$, $p=.54$). Greater baseline level of smoking ($B=.44$, $SE=.04$, $p=.0001$) and presence of a substance use disorder ($B=2.20$, $SE=.82$, $p=.008$) were associated with more smoking during follow-up. The main linear effect of time was nonsignificant ($B=.02$, $SE=.02$, $p=.23$), although there was a significant negative quadratic effect of time ($B=-.002$, $SE=.001$, $p=.04$). Quit attempters also evidenced less smoking during the follow-up than the other two change groups combined ($B=-1.56$, $SE=.66$, $p=.02$), although there was not support for an interaction of this effect with the linear effect of time ($B=.001$, $SE=.03$, $p=.97$) or the quadratic effect of time ($B=-.003$, $SE=.002$, $p=.14$), suggesting that the rate of change in smoking levels over the follow-up period was not significantly different for this group. In other words, the difference in smoking levels between quit attempters and the other change groups remained stable over the follow-up period. Reducers evidenced less smoking across the follow-up than maintainers ($B=-2.22$, $SE=.44$, $p=.0001$), which is to say that reducers exhibited lower mean levels of smoking during the follow-up. However, there was an interaction of this group effect with the linear effect of time ($B=.06$, $SE=.02$, $p=.003$) but not an interaction with the quadratic effect of time ($B=-.001$, $SE=.001$, $p=.75$). This result reflected that smoking levels increased across follow-ups for the reducers but not for the maintainers. As seen in Figure 1, reducers and maintainers appeared to change their smoking behavior differentially over the 12-month follow-up. Reducers gradually increased their smoking level and maintainers gradually decreased their smoking. The effects of age, presence of an anxiety disorder, and posthospitalization intentions were not significant (p values $>.05$).

Posthospitalization quit attempts

Figure 2 presents percentages of quit attempts for each week across the follow-up period for each of the smoking change groups. Percentage quit in the quit attempters varied widely from a high of 83.8% in the first week following the initial posthospitalization quit attempt to a low of 24.2% during weeks 41 and 42. Reducers exhibited the lowest percentage of quit attempts during the first week (6.7%) and the highest percentage during week 14 (25.9%). Maintainers similarly evidenced the lowest percentage of quit attempts during week 1 (1%) with a high of 14% in week 36. Overall, changes in percentage of quit attempts were most notable in the first 3–4 months. During this time, quit attempters exhibited a rapid decrease in the number of teens who were in a quit attempt. Among the reducers, the number of teens making a quit attempt increased steeply during this time period, but quit attempters still maintained higher weekly quit attempt percentages compared with reducers. Maintainers exhibited a more modest increase in percentage of quit attempts that generally continued throughout the follow-up period.

Repeated measures analyses for binomial outcomes were conducted using GEEs to examine smoking change group differences in percentage quit over the follow-up period. In these models, the same independent variables and covariates were used as in the hierarchical linear models, including the linear and quadratic effects of time. Estimates of effects are reported using models that remove higher-order interactions and nonsignificant terms using the same strategy described for HLM. Analyses were conducted in SPSS using a GEE macro (Methodology and Statistics Group, 1998) with the logit link function and an exchangeable correlation matrix specified. Orthogonal contrasts capturing the effects of smoking change groups were equivalent to those used in HLM. Results indicated no significant difference between the BA and MI treatment conditions in the odds of quitting across the follow-up period ($B=-.24$, $SE=.27$, $OR=.79$, $p=.38$). Greater baseline level of smoking ($B=-.05$, $SE=.02$, $OR=.95$, $p=.004$) and presence of a substance use disorder ($B=-.87$, $SE=.30$, $OR=.42$, $p=.004$) were associated with lower odds of quit attempts over the follow-up period, and having an anxiety disorder was associated with higher odds of quit attempts during follow-up ($B=.88$, $SE=.30$, $OR=2.78$, $p=.003$). The main linear ($B=-.004$, $SE=.004$, $p=.25$) and quadratic ($B=.0001$, $SE=.$

001, $p=.69$) effects of time were not significant. Quit attempters also had higher odds of quit attempts during the follow-up than the other two change groups combined ($B=.74$, $SE=.21$, $OR=2.10$, $p=.0004$). However, we also found a significant interaction of the group effect with the linear effect of time ($B=-.03$, $SE=.004$, $p=.0001$) and a significant interaction with the quadratic effect of time ($B=.002$, $SE=.001$, $p=.0001$). As can be seen in Figure 2, these results indicate that for quit attempters ($B=-1.16$, $SE=1.4$), the initial increased odds of making a quit attempt was not maintained across time. The overall odds decreased more rapidly in the first months after discharge, at which point quit attempters' odds of making a quit attempt became similar to those of the other change groups. Overall, reducers were more likely to make quit attempts during the follow-up than maintainers ($B=.51$, $SE=.17$, $OR=1.67$, $p=.003$), and this effect did not differ across the follow-up period. The effects of age and posthospitalization intentions were not significant (p values $>.05$).

Posthospitalization abstinence rates

Repeated measures analyses for binomial outcomes were conducted using GEEs to examine smoking change group differences in biochemically verified 7-day point-prevalence abstinence rates at 1-, 6-, and 12-month follow-ups. Rates at 1, 6, and 12 months were 25.7%, 9.1%, and 28.1% for quit attempters; 12.5%, 9.5%, and 10.0% for reducers; and 4.2%, 11.0%, and 5.6% for maintainers. Smoking change group contrasts, as well as covariates found to be significantly related to abstinence rates in the primary outcomes paper (i.e., baseline smoking level and presence of an anxiety disorder; R. A. Brown et al., 2003), treatment condition, and the effect of time were used in the GEE model. Results indicated no significant differences in abstinence rates across the change groups (p values $>.05$).

Discussion

The present study examined how initial changes in smoking behavior following an intervention related to longer-term smoking and cessation outcomes among adolescent smokers hospitalized for comorbid psychiatric problems. As expected, we found that making a quit attempt in the first week following treatment/hospitalization (quit attempters) corresponded to lower average rates of smoking in the follow-up period. Quit attempters also were more likely to attempt to quit during the follow-up period than were the other change groups, particularly in the first few months following intervention. Adolescents who reduced their smoking by 50% or more immediately after the intervention (reducers) maintained a lower level of smoking during the 1-year follow-up compared with adolescents who did not reduce their smoking significantly immediately after the intervention (maintainers). Adolescents who made significant reductions (reducers) tended to increase their smoking levels slightly over time whereas maintainers gradually decreased their smoking behavior. In all models, group differences were stronger in the first few months and decreased over time. Across analyses, baseline levels of smoking and presence of a substance use disorder were important correlates of smoking and cessation outcomes, and presence of an anxiety disorder was important for cessation outcomes only. No change group differences were found in abstinence rates.

The importance of making a quit attempt immediately subsequent to treatment was reflected in the greater likelihood of being engaged in quit efforts across the follow-up period compared with those who did not attempt to quit postintervention. Although we cannot infer causation, our findings are consistent with recent experimental research with adult smokers indicating that prior abstinence plays a causal role in subsequent abstinence (Heil et al., 2004). Additionally, the public health significance of increasing overall rates of quit attempts has been emphasized among adults (Hughes, 1999) and translates to these high-risk adolescent smokers as well. In this context, making a quit attempt post-treatment appears to be a valid intermediate outcome toward continued efforts at change (i.e., quit attempts) among adolescent established

smokers, supporting interventions that at minimum increase the chances that youth will make an attempt to quit smoking (e.g., Krishnan-Sarin, Cavallo, McFetridge, Liss, & Dahl, 2006; Myers & Brown, 2005).

Even though the quit attempters maintained a greater percentage of individuals who attempted to quit compared with the other change groups, the influence of making a quit attempt on subsequent likelihood of quitting deteriorated rapidly in the first few months following treatment. Youth in the quit attempter group likely relapsed or engaged in fewer cessation attempts across this period. Thus, consistent with the lack of treatment effects found for brief MI-based interventions among adolescent smokers (e.g., R. A. Brown et al., 2003; Colby et al., 2005), helping adolescents sustain cessation attempts, at least in the present high risk sample of youth with acute psychiatric comorbidity, likely requires more intensive intervention. Considering that smokers typically engage in a number of attempts at quitting before they are successful (Fiore, 2000), it is important to continue investigating the predictive validity of initiating quit attempts earlier (i.e., during adolescence) in a smoker's trajectory in its potential relationship with future cessation of smoking behavior and disruption of the development of nicotine dependence and entrenched smoking patterns. Additionally, quit attempt duration as an intermediate outcome to future abstinence warrants investigation among both adolescent self-quitters and those involved in smoking interventions (Mermelstein, 2003).

Although initial reductions in smoking of at least 50% (reducers) corresponded with overall smoking reductions in the follow-up period, these reductions in smoking were not maintained. Surprisingly, the number of cigarettes smoked per day decreased slightly among those who reduced less than 50% (maintainers) in the first week. These findings are consistent with a study of reduction in consumption among adult smokers indicating that those who reduced by a greater percentage of cigarettes per day were less likely to maintain those changes (Hyland et al., 2005). However, reducers still maintained lower levels than prior to the smoking cessation intervention, consistent with other more intensive smoking interventions among adolescent smokers that indicated significant post-treatment reductions in smoking (e.g., Hanson, Allen, Jensen, & Hatsukami, 2003; Killen et al., 2004; Smith et al., 1996). Thus initial reduction in smoking may be one viable intervention target for high-risk adolescents not yet ready to attempt cessation (e.g., Hanson, Zylia, Allen, Avery, & Hatsukami, 2006), although maintaining reduction in smoking levels across longer periods of time may be difficult.

It is possible that reductions in overall smoking level may lead to compensatory strategies such as changes in inhalation patterns (Moolchan, Aung, & Henningfield, 2003) and thus that reductions may convey alternative risks that have yet to be examined among adolescents. As an important caveat, we did not gather information as to whether or not reductions in the present study were intentional. In light of the variability in adolescent smoking patterns, we would suggest that intentionality be an important component in future investigation of smoking reduction efforts so as to distinguish among purposeful efforts at change, natural variability in smoking level related to less established patterns (e.g., smoking less on weekdays than on weekends), and environmental constraints on access to cigarettes leading to temporary reductions. Moolchan and colleagues (2003) have presented arguments both for and against "exposure reduction" as a possible intervention goal among adolescent smokers, suggesting that the utility of smoking reductions as both an intermediate outcome toward cessation and an outcome in its own right as part of a harm reduction focus deserves continued empirical investigation and debate.

Similar to some findings among adult smokers (e.g., Hyland et al., 2005), reducers in the present study had a greater likelihood of quit attempts than maintainers, although these differences in cessation efforts did not vary across time. The burst of quitting exhibited by the reducers between the third and fifth months post-treatment is surprising and, although speculative, may

be reflective of a delayed cessation process initiated as part of the postintervention reduction. Interestingly, both reducers and maintainers exhibited a slight increasing trend in percentage making quit attempts across a large portion of the follow-up period. Although it is unlikely that treatment effects from the present study's brief interventions were maintained over that extended period of time, identification of factors that contribute to delayed cessation efforts subsequent to treatment require investigation among adolescent smokers. As we continue to learn about the role that smoking reduction may play in the cessation process for adolescents, gathering more refined data that discriminates among various types of and contexts for reductions can contribute to greater understanding of adolescent smoking change efforts.

In contrast to the change group differences found across likelihood of quit attempts and average rates of smoking during follow-up, we did not find significant differences across the change groups in biochemically verified abstinence rates. These findings are in contrast to studies among adults that have found reductions in smoking to correspond to future cessation (e.g., Carpenter et al., 2004; Hyland et al., 2005; Etter et al., 2002; Farkas, 1999), although these studies did not use biochemical verification of abstinence at follow-up. Cotinine-verified 7-day point-prevalence abstinence rates were generally in the expected direction across the three groups, but these percentages fluctuated considerably across the three time points. Additionally, the general week-to-week variability in smoking behavior and likelihood of quit attempts in this adolescent sample may not have been captured adequately by 7-day point prevalence. It has been recommended that longer periods of abstinence (i.e., 30 days) be considered for adolescent smokers, given the general variability in their smoking behavior (Mermelstein et al., 2002), although these longer periods of time are more difficult to verify biochemically.

The present research has several limitations. The sample consisted of a relatively homogenous group of smokers, in that a substantial portion were established daily smokers with acute psychiatric comorbidity, which likely limits the ability of the present findings to be generalized to other adolescent smokers. In addition, participation refusal may have resulted in an overrepresentation of adolescents with an interest in quitting smoking, and nonparticipation of youth based on study exclusion criteria may have biased results related to potential differential relationships between demographics or smoking experience and these exclusion criteria. As we alluded to earlier, we are unable to infer causation from the initial self-selected changes in smoking. Future studies are indicated in which reductions or cessation efforts are experimentally manipulated or in which individuals are assigned to one type of change group to provide greater confidence that these initial efforts at change have predictive utility to subsequent cessation or smoking reduction among youth (Carpenter et al., 2004). Also, patients may have reduced their smoking because of the smoking intervention, given that they were restricted from smoking while hospitalized, or because their rates of smoking coming into the hospital were elevated. Although change groups in the present study were determined based on prior research with adults (e.g., Hyland et al., 2005), dichotomizing reduction efforts may have limited power to detect an effect; and with larger samples, increasing the number of identified reduction groups may produce different results. Alternatively, the lack of differences in baseline smoking levels and other important covariates (i.e., gender, psychiatric diagnoses) across the three change groups strengthens the use of these categorizations. Finally, we examined a limited number of covariates in the present study, and future research would benefit from investigation of other theoretically important characteristics (e.g., smoking outcome expectancies, environmental exposure to smoking) that may differentiate those who engage in quit or reduction efforts. For example, given the close association of adolescent cigarette use with the use of other substances, particularly alcohol and marijuana (e.g., Ramsey et al., 2005), it would be of substantive interest to examine the relationship between cessation or, conversely, return to substance use with quit and reduction efforts in youth.

Keeping in mind the aforementioned limitations, results of the present study have several implications for studying smoking cessation processes among high-risk youth. Collection of continuous TLFB data across the follow-up period allowed us to examine in detail how smoking and cessation processes unfolded over time among the present sample of youth. Thus, along with others (Lewis-Esquerre et al., 2005; Mermelstein et al., 2002), we recommend obtaining this level of detailed data whenever possible as part of adolescent smoking treatment outcome studies to better understand how a given intervention influences subsequent smoking and cessation patterns beyond point-prevalence estimates. Additionally, immediate postintervention outcomes, especially engaging in a quit attempt, were important markers for distinguishing cessation and smoking patterns across a significant period of time and should be reported in adolescent smoking treatment studies (Mermelstein et al., 2002). Such intermediate outcomes can aid in identifying adolescents requiring an increased level of support for sustaining change, developing further goals for cessation among those who may be reducing as a step toward quitting, or helping those who have relapsed to recycle into renewed efforts at cessation. As the study of adolescent smoking cessation continues to advance, the use of intermediate outcomes such as quit attempts and smoking reductions can aid in increasing our understanding of behavioral processes of change in this important developmental group.

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Figure 1.
Average cigarettes per day for each smoking change group across follow-up.

Figure 2.
Percentage of quit attempts for each change group across follow-up.

Table 1

Demographics, smoking history, and psychiatric diagnoses for smoking change groups.

Variable	Quit attempters (<i>n</i> =37)	Reducers (<i>n</i> =45)	Maintainers (<i>n</i> =101)
Demographic			
Mean age, years (<i>SD</i>)	16.1 (1.3)	15.4 (2.6)	15.9 (1.3)
Gender (% female)	59.5	62.2	65.3
Ethnicity (% White)	94.6	95.6	94.1
Smoking history			
Mean age at smoking initiation, years (<i>SD</i>)	11.3 (2.5)	11.2 (2.3)	11.2 (2.0)
Mean level of nicotine dependence on FTND (<i>SD</i>)	4.8 (1.9)	4.9 (1.6)	4.9 (1.9)
Mean past 90-day cigarettes per smoking day (<i>SD</i>)	13.9 (9.2)	15.3 (9.0)	14.0 (9.8)
Daily smokers (%) (<i>p</i> =.051)	48.6	73.3	55.4
Lifetime quit attempts (% yes)	73.0	60.0	51.5
Quit attempt in past year (% yes)	62.1	44.4	44.6
Intend to quit posthospitalization (% yes)*	64.9	17.8	19.8
Psychiatric diagnosis			
Affective disorder (% yes)	43.2	44.4	44.6
Anxiety disorder (% yes)	62.2	62.2	51.5
Disruptive disorder (% yes)	81.1	75.6	80.2
Substance use disorder (% yes)	67.6	82.2	67.3

Note.

*
p<.05.