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Update of Adolescent Smoking Cessation Interventions: 2009–2014

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Abstract

The treatment of adolescent tobacco dependence is an imperative public health goal. Adolescent-focused smoking cessation interventions have shown modest results at most, indicating the need for the development of innovative and effective interventions for this vulnerable population. This review aims to provide an update of smoking cessation interventions for youth by reviewing the literature published between 2009 and November 2014 evaluating psychosocial and pharmacological interventions. Based on this examination, future directions for research in advancing the development of adolescent-focused tobacco treatments are provided.

Keywords

adolescent smoking cessation; behavioral treatment; nicotine replacement therapy; bupropion; varenicline

Introduction

Adolescent cigarette smoking remains a major public health concern. Globally, 7% of adolescent girls and 12% of adolescent boys report being current smokers [1]. Smoking initiation in adolescence is strongly correlated with chronic cigarette smoking in adulthood [2]. Given that achieving smoking abstinence at a younger age is associated with greater health benefits than quitting at an older age [3], it is important to develop efficacious treatment for adolescents.

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Conflict of Interest

Patricia Simon, Grace Kong, Dana A. Cavallo and Suchitra Krishnan-Sarin declare that they have no conflicts of interest.

Compliance with Ethics Guidelines

Human and Animal Rights and Informed Consent

Informed consent, approved by the Yale School of Medicine IRB, was obtained from each subject in the study performed by the authors [22].

There are two broad categories of adolescent smoking cessation interventions: psychosocial and pharmacological interventions. Among psychosocial interventions, interventions based on motivational theory, cognitive-behavioral theory, and social-cognitive theory demonstrate efficacy for promoting smoking cessation [4–8]. Results for pharmacological interventions (e.g. nicotine replacement therapy) for adolescent smokers are promising but more research in larger samples is needed to determine its efficacy for adolescent smoking cessation [4].

The most recent Cochrane review of adolescent smoking cessation interventions, psychosocial and pharmacological, used stringent inclusion criteria, limiting their analysis to randomized controlled trials (RCTs) and follow-ups to at least six months [8]. They found moderate effects showing improved smoking cessation outcomes relative to control for interventions guided by the Transtheoretical Model of change (TTM) and Motivation Enhancement (ME). Additionally, they did not observe significant effects for Nicotine Replacement Therapy (NRT) or bupropion relative to placebo. This review concluded that there is insufficient evidence to suggest that one theoretical approach is more effective than others in helping adolescents to quit smoking [8].

A review that uses less stringent criteria may provide a more comprehensive perspective on innovations in adolescent smoking cessation. In the current review, we aimed to provide a narrative review of the studies published in the past five years to evaluate new trends in adolescent smoking cessation interventions. Table 1 lists 22 studies published in the past five years and categorizes each study according to the theoretical model and the method of delivery. Below we review these studies based on their theoretical approaches. Most recent studies are multi-theoretical and we classified them based on what appears to be the primary theoretical model component being evaluated in the study.

Psychosocial Interventions

Recent psychosocial interventions have been guided by social and cognitive approaches (e.g., Cognitive Behavioral Theory [CBT]), Contingency Management (CM), motivational approaches (e.g., TTM, ME), the Psychosocial Dependency Model (PM), and the Addiction Model (AM).

Social and Cognitive-Based Approaches

Social and cognitive-based approaches, such as CBT and social cognitive theory (SCT) are the most frequently examined approaches for adolescent smoking cessation. CBT posits that maladaptive thoughts and emotions maintain smoking behavior. CBT for smoking cessation focuses on teaching skills to manage withdrawal symptoms and prevent relapse using self-monitoring, coping skills (e.g., stress management), stimulus control, positive reinforcement for abstinence or reduction of smoking, and by increasing self-efficacy. SCT, a variant of CBT posits that smoking behavior may be changed by altering social interactions among various cognitive, environmental and behavioral factors to promote abstinence [9].

Since 2009, seven CBT/SCT studies have been published. Two were clinical trials examining American Lung Associations (ALA)’s Not on Tobacco (NoT). NoT is one of the

most thoroughly investigated psychosocial adolescent smoking cessation interventions [10] and is listed by the Substance Abuse and Mental Health Services Administration's [SAMHSA, 11] as a model treatment for smoking cessation among adolescents. NoT is delivered in a gender-specific group format to help adolescents quit or reduce cigarette smoking, increase alternative healthy lifestyle behaviors, and learn stress management, decision-making, coping and interpersonal skills.

Joffe, McNeely, Colantuoni, et al. [12] conducted an RCT examining shorter session duration of NoT (n = 92) and Kickin' Butts (KB; n = 104) with a single informational-session control group in separate high schools (NoT school control n = 102; KB school control n = 89) in Maryland (USA). NoT and KB are similar in that both interventions teach adolescents to assess their smoking patterns and practice self-control. NoT and KB differ in that NoT addresses risk factors across multiple ecological levels (individual, family, community…etc.). Results using Bayesian analysis showed that students in the NoT program had higher cotinine-confirmed quit rates at the end of treatment (EOT; 23% vs. 19%) and at 1 month follow-up (18 % vs. 11%) compared to students in the control condition, but not at 6- or 12- month follow-ups. The quit rates of the students in the KB program did not differ from its respective control group at EOT and at follow ups. A second study by Horn, Dino, Branstetter, et al [13] evaluated NoT with and without adjunctive physical exercise and a 15-minute brief intervention (NoT n = 13; NoT+FIT n = 13; BI n = 14; M age = 16.53 years) among adolescents from West Virginia (USA) who smoked at least once a month [13]. Adolescents in NoT+FIT received verbal encouragement to exercise, a physical activity log and a pedometer. At 3-month post-baseline, CO-validated, 7-day quit rates showed that girls in NoT performed better than girls in BI (13.5% vs. 0%), whereas boys performed better when they were in NoT+FIT compared to BI (23.7% vs. 9.7%). At 6-month post-baseline, NoT+FIT participants were less likely to have smoked than BI participants (31.3% vs. 15.9%).

One study examined CBT-based intervention in Native American adolescents in the USA. Patten, Fadahunsi, Hanza, et al. [14] conducted a group-based intervention for Alaskan Native adolescent smokers, which included talking circles, personal stories from elders and recreational activities. A group randomized trial (; program n = 41[M age = 14.5 years]; wait-list control n = 27 [M age = 14.3 years]) of this intervention did not show an intervention effect relative to control on 7-day self-reported point prevalence (pp) tobacco abstinence at EOT and 6-month follow-up (10% vs. 0% at both time points). However, at EOT, participants in the intervention reported reduced frequency tobacco use compared to baseline.

Two other studies examined the use of CBT-based interventions in Korean [15] and French [16] adolescents. Chun, Bae and Min [15] evaluated CBT for smoking cessation among middle school smokers in South Korea; specifically, they compared a 6-session CBT intervention (n = 35) with a one hour education session (n = 45) using a pretest-posttest non-equivalence control group design. At EOT, intervention participants had significantly lower nicotine dependence relative to control condition. However, there was no significant difference in self-reported or biochemically confirmed abstinence.

Minary, Cambon, Martini, et al. [16] conducted a quasi-experimental study of *TABagisme chez les ADOlescents* (TABADO) among adolescent smokers (*M* age = 16.9 years; TABADO *n* = 386 [87.8% daily smokers; *M* age = 16.8 years]; control *n* = 557 [90.4% daily smokers; *M* age = 16.9 years]) in vocational training centers in France. In the TABADO condition, all participants received an information session about tobacco use and 18.1% of the TABADO participants chose to participate in the enhanced program (EP), which included four group CBT sessions and nicotine replacement therapy. Thirty day pp abstinence at 12-month follow-up showed that TABADO was more effective than the standard care control condition (10.6% vs. 7.4%). The addition of EP did not seem to enhance treatment effects (EP: 5.7%; non-EP TABADO: 11.7%).

Bailey, Hagen, Jeffery, et al. [17] compared an extended duration CBT intervention (*n* = 71) with standard school-based CBT group counseling (*n* = 70) among adolescent smokers from California (USA) who smoked at least 10 cigarettes per day (*M* age = 16.9 years). In both conditions, adolescents received 10 weeks of CBT group counseling and 9 weeks of nicotine replacement. The extended intervention involved 9 additional sessions over the course of 14 weeks. The extended intervention took a scaffolding approach, decreasing supports as youth developed skills for smoking cessation. Results of bio-confirmed 7-day pp abstinence at 6-month follow-up showed that extended CBT participants had higher abstinence rates compared to standard CBT participants (21% vs. 7%). Pbert, Druker, DiFranza, et al. [18]'s *Calling It Quits* combined CBT with a different modality (i.e., 5A's: Ask, Advise, Assess, Assist, Arrange). The 5A's approach is a set of smoking cessation guidelines recommended for all health professionals and endorsed by the USDHHS [19]. An RCT among adolescent smokers (*M* age = 16.8; 61.8% daily smokers) from Massachusetts (USA) compared 4 sessions of *Calling It Quits* provided by a nurse (*n* = 486) to a 4 session, information-attention control (*n* = 582). The findings showed that *Calling It Quits* yielded significantly greater saliva cotinine -validated cessation rates than the control at 3-month follow-up among boys (10.4 % vs. 2.3%) but not among girls (4.3% vs. 5.5%). However, these effects were not sustained at 12-month follow-up.

Contingency Management

Contingency Management (CM) or behavioral reinforcement programs are based on the principles of operant conditioning. Smoking, an operant behavior, is maintained by both the positive effects of nicotine consumption and the negative effects of nicotine withdrawal. CM interventions use positive reinforcement to promote abstinence [20]. Existing CM interventions for adolescents are characterized by short intervention periods and a variable amount of incentives ($17.49-$94.50; [21]) for achieving and maintaining tobacco abstinence. A narrative review of CM interventions showed that CM with adolescents is feasible and that participation in CM-based interventions was associated with reductions in smoking [21]. Since that review, Krishnan-Sarin, Cavallo, Cooney, et al. [22] conducted an RCT examining the independent and combined effects of CM and CBT among Connecticut (USA) adolescent smokers (*M* age = 16.1 years; *M* cigarettes smoked/day = 14). Participants in the CBT condition participated in weekly, 30-minute CBT sessions and those in the CM condition were reinforced for abstinence on an escalating magnitude schedule. At EOT, 7-day pp abstinence rates for CM (*n* = 25) and CM+CBT (*n* = 31) did not significantly

differ from each other, but were superior to abstinence rates observed for CBT (*n* = 26; 36.3%, 36.7% and 0%, respectively). There was some advantage for CM+CBT for time to first cigarette during treatment (CBT: Day 3, CM: Day 9, CM + CBT: Day 20). However, there was no difference observed at one and three month follow ups.

Motivation-focused Interventions

Motivation-focused interventions may be guided by TTM [23] or MI [24]. TTM posits that abstinence can be achieved through increasing motivation to quit through movement in the following stages: Precontemplation, Contemplation, Preparation, Action, Maintenance and Relapse [25]. Two trials have examined the use of TTM approaches among adolescent smokers since 2009.

Specifically, Shi, Jiang, Yu and Zhang [26] conducted a cluster RCT examining the effectiveness of a 12-week long intervention relative to an information pamphlet only control (*n* = 87) among high school, weekly smokers in Shanghai, China. The intervention provided TTM stage-matched text messages based on 5 topic areas: a) health risks of smoking, b) reasonable attitudes towards smoking, c) how to initiate a quit attempt, d) quitting-related skills, and e) refusal skills and relapse prevention (*n* = 92). In addition to providing stage-tailored feedback via text messages, participants were encouraged to use online chatting to support cessation. While there was not a significant intervention effect for 7-day or 30-day pp abstinence at EOT, the intervention condition, relative to the control condition yielded higher rates of smoking reduction (66% vs. 35%) and advancement through quitting stages (52% vs. 18%).

Additionally, Haug, Schaub, Venzin, et al. [27] conducted a cluster RCT in Switzerland to test the efficacy of a 3-month text messaging intervention (SMS-COACH; *n* = 372) relative to an assessment-only control group (*n* = 383) among a sample of 76.4% daily smokers and *M* age = 18.2 years. SMS-COACH was based on the Health Access Processes Approach (HAPA). HAPA is a motivation-focused approach to smoking cessation and builds upon TTM by identifying the social-cognitive processes (expectancies, risk perception, perceived self-efficacy, planning processes and self-regulation) that contribute to progression from non-active stages of change (precontemplation, contemplation and preparation) to active stages of change (action and maintenance). SMS-COACH activities included an online smoking assessment, weekly text message–based smoking assessment, two weekly tailored text messages, and a quit day/relapse prevention text message. At 6-month post-baseline, the intervention and control groups showed no difference in 7-day pp abstinence (12.5% vs. 9.6%) or 4-week pp abstinence (6.3% vs. 5.5%). At follow-up, SMS-COACH participants, did however reduce their cigarette consumption relative to control.

MI is an approach that is closely related to TTM. MI acknowledges that individuals are ambivalent toward change and is thought to influence smoking cessation through resolution of this ambivalence toward change (Rollnick & Miller, 1991). Motivation Enhancement Therapy (MET) is an adaptation of MI. In MET, counseling strategies are personalized and objective feedback is incorporated and delivered using the MI framework. Evidence suggests that motivation-focused interventions are efficacious as stand-alone smoking cessation interventions, however the effects tend to be small [28]. Thus, motivation-focused

interventions are more often utilized as an adjunct to existing interventions [28]. Since 2009, seven smoking cessation interventions for adolescent smokers have evaluated MI alone or in combination with other psychosocial interventions.

Audrain-McGovern, Stevens, Murray, et al. [29], conducted a 12-week RCT comparing 5 sessions of MI (n = 177) and 5 sessions of structured brief advice based on the 5A's (n = 178) among adolescent monthly smokers (age 14–18) from Pennsylvania (USA). Results showed that there was no significant difference between MI and 5A's at EOT (6% vs 7%) and 6-month follow-up: (6% vs 6%) on cotinine-validated 7-day pp abstinence. Interestingly, participants in the MI condition showed greater reductions in cigarettes smoked per day relative to participants in the 5A's condition (reduction in cigarette use per day= MI: 5.3, 5A's: 3.3).

Dalum, Paludan-Muller, Engholm and Kok [30] compared a one-session, 3–5 minute MI session and self-help materials (n = 642) with a waitlist control (n = 505) among adolescent daily smokers (M age = 17.7 years) in Denmark. Intervention participants were more likely than those in the waitlist control condition to self-report being abstinent at one-month (4.8% vs. 1.5%) but not at the 12-month follow-up (7.5% vs. 7.1%).

Peterson, Kealey, Mann, et al. [31] examined the use of a telephone-delivered MI intervention. Fifty high schools in Washington State (USA) were randomly assigned to either the phone intervention (n = 25 schools; n = 1,058) or no-intervention control condition (n = 25 schools; n = 1,093). Adolescent monthly smokers in the phone intervention initially received 5-minutes of telephone counseling to quit smoking. At this time, adolescents who were not motivated to quit received up to 3 consecutive phone sessions. If adolescents were initially motivated to quit or became motivated to quit after the 3 sessions, they received up to 6 consecutive sessions. The intervention also included school-based print and electronic media and access to a change stage-tailored website. Intervention participants, when compared with the control group, had significantly higher self-reported seven-day (47.5% vs. 40.0%), one-month (35.5% vs. 28.7%), and 6-month (21.8% vs. 17.7%) prolonged abstinence rates.

Four other studies examined the use of MI combined with other psychosocial interventions. Colby, Nargiso, Tevyaw, et al. [32] added a one-week telephone booster session (15–20 minutes) and a brief parenting intervention (15–20 minutes) to an in-person, individual MI session (15–20 minutes) using an RCT design among adolescents who smoked at least once a week (M age = 16.2 years). They compared this enhanced MI condition (n = 79) to a brief advice session (BA; n = 83). While they did not observe significant differences between MI and BA for CO and saliva cotinine-confirmed smoking abstinence at 1-month (4.5% vs 1.4%) and 3-month (3.3% vs. 6.8%) follow-ups, participants in the MI condition significantly reduced the number of cigarettes they smoked at 1-month follow-up.

Bühler, Wegmann, Schmidt, et al. [33] examined the *Losgelöst* intervention, which combines CBT and MI in 5 group sessions, one individual session, and a 4-week aftercare phase. During the aftercare phase, the participants receive one phone call and three MI-based short message services (SMS) via mobile telephone. A one-group-pretest-posttest

design of this intervention among 139 adolescents (*M* age = 14.9 years; daily smokers: 86%) in Germany showed that 30.2% smokers had reported quitting and 37.7 % had reported reducing cigarette their consumption by half. Following after care, 24.4% were self-reported to be abstinent.

Guo, Liao, Chang, et al. [34] compared a 12-week intervention that incorporated ME, skill building sessions and alternative medicine to an educational flyers-only control among Taiwanese adolescents in vocational high schools (intervention *n* = 78; control *n* = 65). The intervention consisted of 6 45-minute classroom sessions, self-study materials, coupon-based incentives, and acupuncture training. Additional components included 6 proactive phone counseling sessions and 10 text messages with smoking cessation cues and support. Students could opt to receive urine test after each session and received monetary reinforcement for abstinence. Intervention group urine cotinine-confirmed abstinence rates were significantly higher than control group abstinence rates at EOT (22.7% vs. 1.6%) and 4-month (20.8% vs. 3.2%) follow-up.

Idrisov, Sun, Akhmadeeva, et al. [35] compared Project Ex [36, 37] with standard care control among adolescent monthly smokers attending a summer camp in Russia (*M* age = 16.7 years). Project Ex is listed by SAMHSA as a model treatment for smoking cessation among adolescents [SAMHSA, 11]. The program uses both MI and CBT and is delivered in a group format using enjoyable and motivating games and activities. At 6-month follow-up, intervention participants (*n* = 76) reported a higher rates of past 30-day abstinence than participants in the control condition (*n* = 88; 7.5% vs. 0.1%). Additionally, nicotine dependence was reduced among those who have not quit in the intervention condition at 6-month follow-up.

Addiction Model (AM) vs. Psychosocial Dependency Model (PDM)

The addiction model stresses the physiological aspects of nicotine dependence and how it relates to withdrawal symptoms [38]. In contrast, the psychosocial dependency model emphasizes the role that psychosocial and environmental factors play in continuation of smoking behaviors and their interplay with stress management [38]. In the past five years, one study evaluated the intervention guided by these models. Burton, Chakravorty, Weeks, et al. [39], randomized regular users of smokeless tobacco or cigarettes (*n* = 244) from 16 high schools in California and Illinois (USA) into 5 sessions of PDM intervention, AM intervention, or the control intervention (a quitting tip sheet). Participants in the PDM group were more likely to report abstinence than those in the AM group (50.0% vs. 13.2 %). This difference was not significant in subgroup analyses for smokeless tobacco users only (24.0 % vs. 35.3%). At 4-month follow-up, cotinine-validated cessation rates significantly differed for smokeless tobacco users who participated in any treatment (AM or PDM) versus control group participants (14.3% vs. 0%).

Pharmacological Interventions

Pharmacologic interventions, such as nicotine replacement therapy (NRT), bupropion and varenicline have also been evaluated for adolescent smoking cessation. Meta-analyses have previously shown that there was not a significant effect of these pharmacotherapies for

adolescent smokers [40]. Below, we review recent advancements in pharmacology with adolescent smokers.

Nicotine Replacement Therapy

NRT is the most widely used pharmacotherapy for smoking cessation among adult smokers (Fiore et al., 2000). NRT replaces nicotine obtained from cigarettes to reduce withdrawal symptoms associated with smoking cessation, thus helping resist the urge to smoke cigarettes. Since 2009, one study examined the use of NRT (transdermal nicotine patch)for adolescent smoking cessation. Scherphof, van den Eijnden, Engels and Vollebergh [41] used a randomized, double-blind placebo-controlled trial among 257 adolescents in the Netherlands (*M* age = 16.7 years; treatment *n* = 136; control *n* = 129). Adolescent smokers received an information session followed by 6 or 9 weeks of NRT or placebo. Within the NRT group, participants smoking more than 20 cigarettes per day received a higher transdermal nicotine patch dose (3 weeks 21 mg/day, 3 weeks 14 mg/day and 3 weeks 7 mg/day) to use daily for 9 weeks and those who smoked less than 20 cigarettes per day received a lower transdermal nicotine patch dose (3 weeks 14 mg/day and 3 weeks 7 mg/day) to use daily for 6 weeks. NRT promoted self-reported abstinence at 2 weeks into treatment (31.9% vs. 21.3%), but not at EOT (14.8% vs. 13.1%). More compliant participants had significantly higher prolonged abstinence rates at EOT than less compliant participants (22.4% vs. 7.4%). No differences were observed at 6- and 12-month follow-ups [42].

Varenicline and Bupropion

Varenicline (Chantix) and Bupropion (Zyban) are two approved smoking cessation medications for adult smokers. Varenicline is a partial agonist at the nicotinic receptors which binds to these receptors and may reduce withdrawal effects and cravings. Bupropion is a nicotinic acetylcholine-receptor antagonist that is a dopamine and norepinephrine reuptake inhibitor that has been shown to reduce craving for smoking, irritability and depression symptoms [43]. At present, varenicline and bupropion are not approved for use among adolescents, as no well-powered efficacy trials have been published [8].

Faessel, Ravva and Williams [44] conducted the only published study of varenicline among adolescents. They reported on the pharmacokinetics, safety, and tolerability of varenicline in adolescent smokers (ages 12–16 years, ≥ 3 cigarettes per day) through a multicenter, randomized, double placebo-controlled, parallel-group study. Adolescent smokers were classified into high body weight (>55 kg; *n* = 35) and low body weight (≤ 55 kg; *n* = 37) groups. Within these groups, participants were randomized to receive a dose comparable to the standard adult dose (>55 kg: 1.0 mg twice daily; ≤ 55 kg: 0.5 mg twice daily), a lower dose (0.5 mg once daily) or placebo for 14 days. Among participants with high-body weight, higher varenicline dosage was associated with greater reductions in smoking at 16-day follow-up. Among participants with low body weight, reductions in smoking were similar across standard dose, low dose and placebo conditions.

Gray, Carpenter, Baker, et al. [45] evaluated the combination of bupropion sustained release (BSR) and CM (BSR+CM) relative to various combinations of placebo medication and payment for attendance (non-CM) among adolescents and young adults. The treatment

conditions were BSR+CM (*M* age = 18.4 years; *M* cigarettes smoked per day = 11.3), BSR +non-CM (*M* age = 18.4 years; *M* cigarettes smoked per day = 11.5), Placebo+CM (*M* age = 18.1 years; *M* cigarettes smoked per day = 11.2) and Placebo+non-CM (*M* age = 19.0 years; *M* cigarettes smoked per day = 9.1). Participants were recruited from local secondary schools, colleges, and community. For six weeks, participants weighing at least 90 lbs received BSR 150 mg (or placebo) every morning for 3 days, which was then titrated to 150 mg twice daily. Participants weighing less than 90 lbs received BSR 150mg once daily. In the CM conditions, participants were assessed twice weekly for urine cotinine-confirmed 7-day pp abstinence for 11 total testing opportunities. At EOT, BSR+CM (27.0%) yielded higher abstinence rates than placebo + non-CM (9.4%) and BSR + non-CM (8.3%). At 12-week follow-up, the abstinence rates in BSR+CM were at 10.8% relative to 0% in the placebo +CM condition.

The second study by Gray et al. [46] was a double-blind randomized trial of varenicline (*n* = 15; *M* age = 19.1 years) and bupropion extended release (BXL; *n* = 14; *M* age = 18.7 years) among adolescents who smoked at least 5 cigarettes per day. Following one week titration, dose for varenicline was 1.0 mg twice daily for >55 kg body weight and 0.5 mg twice daily for ≤ 55 kg body weight. BXL participants received 300 mg after 1 week titration. Results showed that receiving 7 weeks of either varenicline or BXL, may contribute to reductions in the number of cigarettes smoked among adolescents. There was, however, no difference in 7-day pp abstinence between varenicline and BXL at EOT (7% vs. 14.3%) or 3-month follow-up (0 vs. 7%). These findings are encouraging but preliminary due to the lack of a placebo control.

Conclusions

In summary, there is evidence to support the short-term efficacy of psychosocial interventions for smoking cessation among adolescents, especially those that contain cognitive behavioral elements. CM and MI have each shown some efficacy as stand-alone interventions. Additionally, interventions that include elements of TTM are a promising avenue. We are beginning to see evidence to support the efficacy of NRT, but there is insufficient evidence to determine the efficacy of pharmacological treatments such as bupropion and varenicline. Innovative delivery methods such as telephone, text messaging and computer/web-based methods have grown in popularity and are used most often with MI-focused interventions. We propose below some areas which could be targeted for improving current smoking cessation interventions for adolescents.

While there have been significant advances in psychosocial and pharmacological interventions, some significant challenges for adolescent smoking cessation remain. First, despite significant intervention effects relative to control conditions, across psychosocial and pharmacological interventions, more than 50% of intervention participants continue to smoke at end of treatment. Over the past five years, the highest EOT bio-chemically confirmed 7-day point prevalence abstinence rates have been reported by a CM/CBT intervention (36.7%; Krishnan-Sarin et al., 2013). The highest self-reported abstinence rates at EOT have been reported by a MI/CBT intervention that used proactive telephone counseling (47.5%; Peterson et al, 2009). Second, intervention effects on abstinence rarely

persist at 6 months. Only 3 studies reported significant intervention effects at 6-month follow up (Bailey, 2013; Horn et al., 2011; Peterson et al, 2009). Only one study reported significant intervention effects at 12-month follow-up (Minary et al., 2012). This suggests that more work needs to be done to improve both smoking cessation and long term abstinence rates among adolescents.

In this regard, it may be important to consider some methods of improving existing interventions. It is possible that smoking cessation interventions can be "tailored" or enhanced by addressing the unique smoking cessation needs of adolescent smokers. Interventions that are tailored to youth's specific stage of change have shown efficacy [26, 27]. Interventions that are gender-specific are also effective [13]. Culturally tailored interventions have shown mixed findings [14, 15]. More research on tailoring interventions is needed. Additionally, attempts to enhance intervention effects through proactive contact initiation with adolescents may have utility. Interventions using counselor-initiated contacts such as proactive recruitment and proactive counseling appear to have significant intervention effects at 4 to 6 month follow ups [27, 31, 34]. Thus, there is some evidence that counselor-initiated contacts may contribute to more durable intervention effects.

We would also like to point out some methodological concerns. Previous reviews have commented that heterogeneous measurements limit comparisons of smoking cessation outcomes and we would like to reiterate this important issue. Over the past 5 years, more studies have reported outcomes according to the standards suggested by the Society for Research on Nicotine and Tobacco [47]. Nevertheless, the outcomes reported varied substantially from self-reported abstinence rates to bio-chemically validated assessments, measures of nicotine dependence or reductions in cigarette use. We need consistency in the measures used to make it easier to compare across interventions. Thus, future research should strive to adhere to recommended assessment measures.

Additionally, the reporting of research methodology regarding interventions needs to be improved. Researchers have acknowledged difficulty with categorizing interventions for literature reviews because programs are guided by "small pieces" of theories or multiple theories [6, 48]. This limits our ability to make strong conclusions about interventions guided by specific theoretical approaches. Perhaps intervention developers should provide more detailed information about the extent to which program elements are guided by a theory and the aspects of a theory that are included or excluded in program development. There is a precedence for assessing how closely programs align with their stated theoretical approach. McDonald et al. [7] in their review of adolescent smoking cessation interventions included ratings of theoretical fidelity for interventions. Using this approach, we can better elucidate the extent to which various theoretical components need to be represented for interventions to be effective.

Finally, more recent interventions have included multiple delivery methods. As Table 1 shows, it is not uncommon for interventions to include some combination of group, individual, computer-based, text-based and telephone-based intervention. Phones have been used to conduct counseling sessions [31] and to send tailored text messages to adolescents [26]. Preliminary evidence suggests that telephone counseling effects persist at 6-month

follow-up [31]. Among adolescents, research has shown that text messaging interventions contribute to reductions in smoking at EOT [26] and at 6-month follow-up [27]. Evidence of their effect on abstinence, however, is lacking. Interestingly, most innovative delivery methods were employed by motivation-focused interventions, perhaps because adapting interventions primarily guided by CBT (or other behavioral therapies) may be more challenging. There is evidence however, that CBT may be adapted for computerized substance abuse treatment interventions among adults [49]. This technology has yet to be transferred to research with adolescents and is another area for future research. Similar to interventions guided by multiple theories, there is limited research examining how the addition of various delivery modes contributes to intervention effects. Getting a better understanding of such differences will pave the way for improving future interventional research.

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Table 1

Theoretical Orientations and Components presented in Smoking Cessation Articles Published from 2009 to July 2014

										Delivery Method				
		Psychosocial					Pharmacological			Face-to-face		Technological		
Author	**Conditions**	**CBT/SCT**	**CM**	**ME/MI**	**TTM/HAPA**	**Other**	**Bup.**	**NRT**	**Var.**	**Group**	**Individual**	**Comp.**	**Tel.**	**Text**
Audrain-McGovern et al., 2011	MI			x							x		x	
	Control (5A's)										x		x	
Bailey et al., 2013	CBTextended /NRT	x						x		x				
	CBT/NRT	x						x		x				
Bühler et al., 2012	CBT/MI (Losgelöst)	x		x						x	x		x	x
Burton et al., 2009	Addiction Model					x				x				
	Psychosocial Dependency model					x				x				
	Control (Information Pamphlet)					x								
Chun et al., 2012	CBT	x								x				
	Control (Information Session)					x				x				
Colby et al., 2012	MI			x							x		x	
	Control (Brief Advice)										x			
Dalum et al. 2012	MI			x							x			
	Control (Waitlist)													
Faessel et al., 2009	Ver.								x		x			
	Control (Placebo)										x			
Gray et al., 2011	CM/Bup.		x				x				x			
	Bup.						x				x			
	CM		x								x			
Gray et al., 2012	Bup.						x				x			
	Ver.								x		x			
Guo et al., 2014	CBT		x							x	x		x	x
	Control (Information Flyers)													
Horn et al., 2011	SCT (NOT+Fit)	x								x				
Jofee et al. 2009	Other (Kickin' Butts)					x				x				
Horn et al., 2011; Jofee et al., 2009	SCT (NOT)	x								x				

		Psychosocial					Pharmacological			Delivery Method: Face-to-face		Delivery Method: Technological		
Author	**Conditions**	**CBT/SCT**	**CM**	**ME/MI**	**TTM/HAPA**	**Other**	**Bup.**	**NRT**	**Var.**	**Group**	**Individual**	**Comp.**	**Tel.**	**Text**
Horn et al., 2011; Jofee et al., 2009	Control (Brief Advice)									x				
Huang et al., 2013	TTM HAPA (SMS-COACH)				X									x
	Control (assessment-only)											x		x
Idrisov et al., 2013	CBT/ME (Project Ex Russia)	x		x						x				
	Control (Standard Care)					x				x	x			
Krishnan-Sarin et al. 2013	CM		x								x			
	CBT	x									x			
	CM/CBT	x	x								x			
Minary et al., 2013	Tabado	x						x		x	x			
	Control (Standard Care)													
Patten et al., 2014	CBT	x								x				
	Control (Waitlist)													
Pbert et al., 2011	CBT (Calling It Quits)	x									x			
	Control (information sessions)										x			
Peterson et al., 2009	CBT/MI	x		x								x	x	
	Control (no intervention)													
Scherphof et al. a, 2014; Scherphof et al. b, 2014	NRT							x		x	x			
	Control (Placebo)										x			
Shi et al, 2013	TTM				x							x		x
	Control (Information pamphlets)													

Note. CBT: Cognitive Behavioral Therapy; SCT: Social Cognitive Theory; CM: Contingency Management; ME/MI: Motivation Enhancement/Motivational Interviewing; TTM: Transtheoretical Model; HAPA: Health Action Process Model; NRT: Nicotine Replacement Therapy; Bup.: Bupropion; Var: Varenicline; Tel: Telephone; Text: Text messaging; Com.: Computer-based/Web-based.