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Factor structure and validity of the Medication Adherence Questionnaire (MAQ) with cigarette smokers trying to quit

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Abstract

The Medication Adherence Questionnaire (MAQ) is a scale used to evaluate adherence to medications. The present study assessed the factor structure and validity of the MAQ with cigarette smokers. A principal components analysis was conducted on MAQ scores from a sample of smokers presenting for treatment in a clinical trial of naltrexone and nicotine patch for smoking cessation (*N*=385). Indices of convergent and predictive validity were tested using electronic medication caps for naltrexone, nicotine patch counts, plasma drug levels of naltrexone, and treatment outcomes. The principal components analysis revealed two factors. Factor 1, labeled "unintentional nonadherence," measured the extent to which individuals were nonadherent because they were careless or forgot to take their medications. Factor 2, labeled "purposeful nonadherence," assessed nonadherence related to purposefully stopping medication use after feeling better or worse. Only the second factor was shown to have good convergent and predictive validity. Specifically, this factor was related to pill-taking behavior measured with electronic medication caps and drug plasma levels and nicotine patch use based on nicotine patch count data, and it was associated with smoking cessation outcome. Thus the purposeful nonadherence factor of the MAQ may be used as a brief screening tool for medication adherence with cigarette smokers seeking treatment. Information obtained with this questionnaire could be used to counsel patients regarding the importance of medication adherence.

Introduction

Adherence to medical regimens has been studied in detail since the 1960s (M. S. Davis, 1968; Korsch, Gozzi, & Francis, 1968). Initial investigations showed fairly high levels of nonadherence to doctors' advice (37%; M. S. Davis, 1968) and high levels of dissatisfaction with treatment by physicians (24%; Korsch et al., 1968). Findings from more recent studies on adherence to medical recommendations have shown that nonadherence is still relatively high. A meta-analysis of over 500 studies showed the average nonadherence rate to be 24.8% (DiMatteo, 2004), and a literature review of medication adherence in clinical trials using electronic medication caps found that across 10 different types of patient populations, including those with diseases such as tuberculosis, hypertension, and HIV infection, the percentage of prescribed doses of medication that were taken ranged from 74% to 100% (Kastrissios & Blaschke, 1997). Moreover, a meta-analysis of studies examining adherence and medical treatment outcomes revealed that adherence to medications was related to medical outcomes (e.g., vision, blood pressure, weight) and that adherence reduced the risk of a poor outcome by 26% (DiMatteo, Giordani, Lepper, & Croghan, 2002). These studies underscore the need for additional investigations that focus both on the assessment of adherence and on interventions designed to improve adherence to medical regimens.

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Adherence to nicotine patch treatment for smoking cessation

Studies assessing adherence rates with transdermal nicotine patch use have generally reported relatively low rates (Alterman, Gariti, Cook, & Cnaan, 1999; Orleans et al., 1994; Stapleton et al., 1995). Additionally, many investigations have shown a relationship between nicotine patch adherence and smoking cessation treatment outcome (Alterman et al., 1999; Cooper et al., 2004; Jolicoeur et al., 2000), and one study showed that advice from health care providers was related to adherence to the nicotine patch (Orleans et al., 1994). Although adherence has been examined in nicotine patch treatment, no studies to date have explored assessment tools to evaluate this important construct.

Adherence to naltrexone treatment for smoking cessation

Although several studies have examined naltrexone for smoking cessation, the results of these investigations have been inconclusive. Two small sample studies showed that naltrexone did not help participants quit smoking (Ahmadi, Ashkani, Ahmadi, & Ahmadi, 2003; Wong et al., 1999), whereas two other small sample studies showed that naltrexone may be beneficial for smoking cessation (King, 2002; Krishnan-Sarin, Meandzija, & O'Malley, 2003). None of these studies reported adherence data or how adherence to naltrexone treatment was related to outcome. The largest clinical trial conducted to date revealed promising results for 100 mg naltrexone combined with nicotine patch but concluded that this treatment requires further study (O'Malley et al., 2006). This investigation also showed a relationship with adherence in that treatment completers in the 100-mg naltrexone group were more likely to be abstinent than were completers in the placebo group. Thus, although adherence has been studied for nicotine patch and for naltrexone treatment, the assessment of adherence to these medications, including how it relates to outcome, is warranted.

The Medication Adherence Questionnaire

Given the importance of medication adherence, designing and evaluating good assessment tools is essential. Morisky, Green, and Levine (1986) developed the Medication Adherence Questionnaire (MAQ) to measure medication adherence for hypertension treatment, and the psychometric properties of this scale appeared adequate in their original study. These researchers showed that the MAQ had good predictive validity, in that individuals who scored in the high adherence range had a significantly better treatment outcome than those scoring in the low adherence range as measured by the MAQ. Although Morisky et al. (1986) reported that they conducted a principal components analysis that revealed a single factor, the details of this analysis (e.g., factor loadings, percent variance accounted for) were not reported.

Since the MAQ was introduced, it has been used in numerous settings. For example, it was used or adapted for use in studies of participants with hypertension (McNagny, Ahluwalia, Clark, & Resnicow, 1997; Shea, Misra, Ehrlich, Field, & Francis, 1992), HIV (Corless et al., 2005; Gao & Nau, 2000; Knobel et al., 2002; Pratt et al., 2001), psychoses (Thompson, Kulkarni, & Sergejew, 2000), diabetes (Krapek et al., 2004; Venturini et al., 1999), cancer pain (Chang, Chang, Chiou, Tsou, & Lin, 2002), cardiac problems (Shalansky, Levy, & Ignaszewski, 2004), mood disorders (C. F. George, Peveler, Heiliger, & Thompson, 2000), osteoporosis (Turbi et al., 2004), thromboembolic disease (N. J. Davis, Billett, Cohen, & Arnsten, 2005), and asthma (Erickson, Coombs, Kirking, & Azimi, 2001).

Several investigations have reported data on the psychometric properties of the MAQ, and the results of these studies have been mixed. For example, coefficient alpha reliability estimates have ranged from low (Pratt et al., 2001; Shalansky et al., 2004), to adequate (Brooks et al., 1994; Morisky et al., 1986), to high (Erickson et al., 2001). Given that the MAQ is a four-item scale with a yes–no answer format, coefficient alpha may not be the best measure of reliability, calling these results into question (Schmitt, 1996). Evidence from studies regarding validity

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estimates also has been mixed, but more studies have reported adequate validity estimates than not (Brooks et al., 1994; Erickson et al., 2001; Gao & Nau, 2000; C. F. George et al., 2000). Of interest, Shalansky et al. (2004) used multivariate regression and found that the MAQ was a significant independent predictor of nonadherence (*OR*=1.6, 95% *CI*=1.2–2.3). They also showed that the two items related to stopping medications on purpose were each independent predictors (*OR*=2.6–3.5, 95% *CI*=1.1–12.0).

As with the findings of psychometric analyses of the MAQ, principal components analyses have yielded mixed results. Thompson et al. (2000) used the MAQ and the Drug Attitude Inventory to create a new medication adherence scale. In this adaptation of the MAQ items, they reported that they conducted a principal components analysis that supported the unidimensionality of the questionnaire's factor structure. However, the details of the principal components analysis were not reported. Pratt and colleagues (2001) conducted a study with the MAQ, the Reported Adherence to Medication Scale, and the Patient Adjustment to Medication Scale. They conducted a principal components analysis on the combination of all of the items of each of these scales. This analysis revealed four factors, and the first and third factors that emerged were interpreted as representing unintentional (i.e., forgetting) and intentional (i.e., altering dose) nonadherence. The first item from the MAQ loaded on the unintentional factor and the second, third, and fourth items all loaded on the intentional factor (see Table 2 for a list of MAQ items). Even though some details of the principal components analysis were provided (e.g., percent variance accounted for), these details would be difficult to compare with a principal components analysis of the MAQ items alone, because the MAQ items were combined with two other scales for this analysis.

Although medications are frequently used in smoking cessation treatments (Fiore et al., 2000), no studies to date have developed or examined an instrument to assess medication adherence by cigarette smokers attempting to quit. Additionally, even though predictors of smoking cessation treatment outcome have been examined at length, adherence to treatment medications in smoking cessation clinical trials has received surprisingly little attention as a predictor (Dale et al., 2001; Swan et al., 2003), with only one controlled study carefully testing this variable (Schmitz, Sayre, Stotts, Rothfleisch, & Mooney, 2005). As a result, the predictive validity of the MAQ for this population was of particular interest. Thus the goal of the present study was to assess the factor structure and validity of the MAQ with cigarette smokers trying to quit.

Method

Participants

The original investigation was a double-blind, placebo-controlled clinical trial for smoking cessation examining whether naltrexone augments the efficacy of the nicotine patch (O'Malley et al., 2006). The study was approved by the institutional review boards of the Yale University School of Medicine, the University of Connecticut, and the Veterans Affairs Connecticut Healthcare System. Participants were eligible for the trial if they were at least 18 years of age, smoked 20 cigarettes/day for at least 1 year, and had a baseline expired carbon monoxide (CO) level of 10 ppm or greater (an average nonsmoker can have a CO reading of 2–6 ppm from environmental sources; SRNT Subcommittee on Biochemical Verification, 2002). Participants were excluded if they were medically unstable, had a major psychiatric disorder, or were alcohol dependent. Of the sample for the clinical trial, 385 participants could be evaluated. Of these, 93 participants received placebo naltrexone and 292 participants received active naltrexone (25 mg, 50 mg, or 100 mg daily). The analyses presented here are based on the placebo group and the group of all participants who received active medication irrespective of dose. Table 1 presents demographics for the entire sample, the placebo group, and the active medication group.

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Procedure

A single administration of the MAQ was completed as part of the baseline screening assessment before participants started study medications and made an attempt to quit smoking. After participants were found to be eligible for the trial, they received a 21-mg nicotine patch daily and were randomized to placebo, or 25, 50, or 100 mg of naltrexone for a 6-week period. During the treatment phase, participants came to the clinic for weekly research appointments. Questionnaires were administered, and brief counseling was provided at each of these appointments. Smoking status was verified biochemically by measuring CO levels with a Vitalograph BreathCO monitor, with readings of 10 ppm or less coded as abstinence (SRNT Subcommittee on Biochemical Verification, 2002). Individuals who dropped out were coded as failures.

Materials

The Medication Adherence Questionnaire—The MAQ is a self-report instrument composed of four items; respondents are asked to answer yes or no regarding items that assess participants' history of medication adherence (Morisky et al., 1986). Items are scored as either 0 (yes) or 1 (no), and previous investigations have typically summed all items to report a total score.

Transdermal nicotine patch count—All participants were given nine nicotine patches at every research interview session that they attended during the treatment phase of the original investigation (i.e., seven patches per week and two extra). Participants were instructed to return any unused patches, and the number of patches returned was counted and recorded at each research session. A measure of patch adherence was calculated as the number of patches dispensed minus the number returned, divided by 42 (i.e., the total number of prescribed doses). For this formula, returns of 0–2 patches were counted as 2 patches. This approach was taken to prevent participants from being coded as having greater than 100% adherence on this measure. For example, if a participant returned 0 patches every week over the 6-week treatment, then the total number of patches dispensed over 6 weeks (i.e., 54 patches) minus the number returned (i.e., 0), divided by 42 (i.e., the number of prescribed doses) would equal approximately 129% adherence. If a subject dropped out of treatment and failed to return their most recently dispensed patches, the patches were assumed not to have been used and were treated in the same way as returns. For subjects who dropped out of treatment in the first week of the study and never returned any patches, this variable was coded as 0% adherence. This method of data collection for the measurement of nicotine patch adherence is somewhat similar to methods used in other reports (Alterman et al., 1999); however, we did not have an item or items assessing the total number of patches consumed (e.g., "Of the 42 patches you received, how many did you use?"; Jolicoeur et al., 2000, p. 506).

Electronic drug exposure monitor—All participants' medication bottles had an electronic drug exposure monitor (eDEM) medication cap. These caps (purchased from APREX, a division of AARDEX, Union City, California) recorded the date and time of each cap opening, as well as the number of hours that elapsed between openings. The bottle also displayed to the participant the number of times the bottle was opened each day, to enhance adherence. Each time a subject attended the weekly treatment appointment, the cap data were synchronized with a computerized database. The consent form stated that the cap on the pill bottle was designed to record each time the pill bottle was opened. Additionally, at the initial treatment session, a nurse practitioner gave all participants verbal instructions describing how the eDEM cap functioned (i.e., a description of the digital display and how it tracked the time between cap openings) and instructed participants to bring in their cap to each research interview session so that the cap data could be obtained. Fidelity to these instructions was not monitored formally during the clinical trial. This is a standard method used to assess adherence

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to medications in clinical trials (Kastrissios & Blaschke, 1997). The dependent variable assessed in the present study was the percentage of presumed doses taken, as assessed by number of actual cap turns divided by 42 (i.e., the number of prescribed doses). As with the patch count data, this variable was coded as 0% adherence for subjects who dropped out of treatment in the first week of the study and never returned their eDEM cap.

Plasma drug concentrations—Serum cotinine concentrations were determined as a measure of chronic nicotine exposure at baseline. Plasma samples were drawn at the end of the first and fourth weeks of the clinical trial to assess levels of naltrexone and 6-beta-naltrexol, a metabolite of naltrexone. Naltrexone undergoes extensive metabolism to 6-beta-naltrexol, which reaches much higher concentrations and is cleared more slowly than the parent compound. For this reason, 6-beta-naltrexol levels were used as an independent marker of adherence. The samples from participants who were randomized to receive naltrexone were coded as either positive or negative (i.e., containing or not containing 6-beta-naltrexol). Plasma samples with a value of 5 μg/L or greater were coded as containing 6-beta-naltrexol, allowing for adequate precision and accuracy in detecting this metabolite in human plasma (Meyer, Straughn, Lo, Schary, & Whitney, 1984).

Results

Principal components analysis

A principal components analysis with varimax rotation was calculated on the four items comprising the MAQ using SPSS 11.0 for Windows. Rotation was used to enhance the interpretability of the solution (Tabachnick & Fidell, 1996). The principal components analysis revealed two factors with eigenvalues greater than 1, accounting for 65.63% of the total variance. In addition, the scree plot demonstrated a break in slope between Factors 2 and 3. Thus, a two-factor solution was selected (Zwick & Velicer, 1986).

To demonstrate good simple structure, only items that loaded over .40 on one factor and less than .40 on all other factors were assigned to a factor (Hatcher, 1994). Factors 1 and 2 each contained two items, which is the necessary number of items typically needed to comprise a factor in principal components analysis (Zwick & Velicer, 1986). The MAQ items and their loadings are displayed in Table 2.

The content of the items from each factor was examined and used to develop factor interpretations and subscale/factor names. Factor 1 appeared to measure the extent to which individuals were nonadherent because they forgot to take their medications; this factor was named “unintentional nonadherence.” High scores on these items relate to higher levels of carelessness and forgetfulness. Factor 2 appeared to assess stopping medication use related to an increase or a decrease in symptom level; this factor was named “purposeful nonadherence.” Higher scores on these items seemed to be associated with purposefully stopping medication use after feeling better or worse.

Validity

Convergent validity refers to evidence of an association between tests of theoretically related constructs (DeVellis, 1991). Thus for this analysis we tested the relationship between MAQ adherence categorization and medication use. Using MAQ scores, we categorized participants with regard to medication adherence by adapting the method used by Morisky et al. (1986). For each factor of the MAQ, participants were categorized as adherent if they answered no to all items and as nonadherent if they answered yes to one or more items. Participants in these categories were compared with regard to their use of naltrexone or placebo and nicotine patches, utilizing eDEM data and nicotine patch count data collected on the 380 participants

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who completed the MAQ. Medication usage was assessed by total percentage of presumed doses taken, with a higher percentage indicating greater adherence. Because eDEM data are generally considered to be more precise than data derived from medication counts (Kastrissios & Blaschke, 1997), we did not expect a perfect correlation between the eDEM cap data and the nicotine patch data. However, consistent with other reports of the correspondence between electronic medication caps and pill count data (Oyugi et al., 2004), the correlation between percentages for these two measures was high, $r(385)=.85$, $p<.05$.

These results were analyzed using independent-samples *t* tests for each factor. Analysis of the eDEM data for Factor 1 showed no significant effect, $t(377)=1.05$, $p=.29$. For Factor 2, the analysis revealed a significant difference between the mean percentage of cap openings observed in the two groups, $t(378)=-3.37$, $p=.001$. The mean percentage of cap openings was significantly higher in the adherent group ($M=79.23\%$, $SD=28.09$), compared with the nonadherent group ($M=68.54\%$, $SD=33.39$). These results provide evidence of good convergent validity for Factor 2 of the MAQ. For the nicotine patch adherence data for Factor 1, we found a marginal effect, but it was not significant, $t(377)=1.88$, $p=.06$. With regard to Factor 2, we found a significant effect favoring the adherent group, $t(378)=-2.78$, $p=.006$. The mean percentage of patches used was higher in the adherent group ($M=82.65\%$, $SD=27.84$) than in the nonadherent group ($M=73.82\%$, $SD=33.75$). The percentage of participants endorsing either item comprising Factor 2 (i.e., items 3 and 4) was analyzed to check whether one item was endorsed considerably more often than the other. From the 380 subjects who provided MAQ data, 22.1% endorsed the answer no on item 3, as compared with 29.9% who answered no on item 4. Thus these findings for the nicotine patch use data provide evidence of good convergent validity for Factor 2 of the MAQ but not for Factor 1.

Convergent validity also was assessed using plasma drug levels for the group of 219 participants who received naltrexone and had a blood sample drawn for drug plasma levels. In this analysis, the association between MAQ adherence categorization and plasma drug levels was investigated. Again, participants were categorized with regard to adherence condition (i.e., coded as adherent if they answered no to all items and as nonadherent if they answered yes to one or more items). These results were analyzed using a chi-square test for each factor. No effects were found for Factor 1 for week 1, $\chi^2(1, 250)=0$, $p=1.00$, and for week 4, $\chi^2(1, 218)=.39$, $p=.53$. Although levels of 6-beta-naltrexol were not associated with adherence categorization for Factor 2 at week 1, $\chi^2(1, 251)=.09$, $p=.76$, plasma levels were associated with this categorization at week 4, $\chi^2(1, 219)=5.34$, $p=.02$. Of the subsample of subjects who had the metabolite 6-beta-naltrexol in their blood sample at week 4, a higher proportion of subjects were classified as adherent (67.19%; 129/192) than as nonadherent (32.81%; 63/192), providing further evidence of convergent validity for Factor 2.

Predictive validity refers to evidence of an association between a measure and some criterion or gold standard (DeVellis, 1991). For instance, in smoking cessation research, scores on a measure would be related to treatment outcome as the criterion, as assessed by point prevalence (i.e., the percentage of the sample that is not smoking during the last week of the study treatment). Treatment outcome and MAQ data were obtained for 380 participants, and for these analyses the placebo ($n=92$) and active medication ($n=288$) groups were analyzed separately. Participants in these groups were again categorized with regard to adherence (i.e., coded as adherent if they answered no to all items and as nonadherent if they answered yes to one or more items). Participants in these categories were compared with regard to their smoking status at the end of the study treatment. For this analysis, participants' smoking status was coded as either smoking or abstinent, with abstinence over the last week determined by self-report and confirmed by a CO level of 10 ppm or less. Participants who dropped out of the study treatment were classified as smoking.

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These results were analyzed using a chi-square test for each factor. We found no significant relationship between adherence status and smoking abstinence at the end of treatment for Factor 1, $\chi^2(1, 92)=.12$, $p=.73$, or for Factor 2 in the placebo group, $\chi^2(1, 92)=1.33$, $p=.25$. Although we found a marginal effect for Factor 1 in the active medication group, $\chi^2(1, 287)=3.76$, $p=.05$, it was not statistically significant. We found a significant relationship on Factor 2 in the active medication group, $\chi^2(1, 288)=4.19$, $p=.04$. Specifically, the proportion of abstinent participants was higher (61.36%; 108/176) for the adherent group than for the nonadherent group (49.12%; 55/112), providing evidence that scores on Factor 2 of the MAQ in the active medication group predicted treatment outcome. These results indicate that the MAQ does not have adequate predictive validity for both the placebo and active medication groups for Factor 1 and for the placebo group for Factor 2. The MAQ appears to have good predictive validity for the active medication group for Factor 2.

Discussion

This study assessed the factor structure and validity of the MAQ with cigarette smokers presenting for treatment in a clinical trial. Although two previous studies reported a single factor (Morisky et al., 1986; Thompson et al., 2000), the present study provided evidence for a two-factor structure for the MAQ. Given that the details of these previous factor analyses were not provided (Morisky et al., 1986; Thompson et al., 2000), clear reasons for this incongruity were unattainable. Possibilities include differences in study characteristics and participant samples. Moreover, it may be that the single factor structure of the MAQ found in previous studies cannot be replicated with smokers participating in a clinical trial. The two-factor structure revealed in the present study was somewhat similar to the results of the principal components analysis reported by Pratt et al. (2001) in that there were factors representing two constructs: Intentional and unintentional nonadherence. The item loadings were slightly different in the Pratt et al. study, but this difference may have been a result of the investigators combining the MAQ items with two other scales.

With regard to the validity analyses, the unintentional nonadherence factor (i.e., Factor 1) was shown to have inadequate indices of validity, whereas the purposeful nonadherence factor (i.e., Factor 2) was found to have good convergent and predictive validity. Specifically, the purposeful nonadherence factor showed good convergent validity as measured with eDEM caps for both the placebo and active treatment groups. The nicotine patch count data provided evidence of convergent validity for purposeful nonadherence with both groups as well. The purposeful nonadherence factor also showed good convergent validity for drug plasma levels in the active treatment group at week 4. Adherence categorization was not associated with drug plasma levels at week 1. Given that this factor assesses stopping medication use on purpose, this lack of a relationship at week 1 in the active medication group is probably related to participants' being more motivated or willing to remain adherent to their medications even if they were feeling better or worse during the first week of treatment. Plasma drug levels also are affected by individual differences in bioavailability or disposition, which may account for these results. In addition, predictive validity for the purposeful nonadherence factor was shown for the active treatment group but not for the placebo group, further documenting the value of this scale in predicting outcome in patients using medications for smoking cessation.

In summary, these results suggest that participants who reported that they tended to discontinue taking their medications for a specific reason were more likely to be nonadherent to their medication regimen and have poorer outcomes, compared with individuals who failed to report this tendency. In addition, knowing that a participant reported being careless or forgetful about taking medications did not predict that the individual would be nonadherent to his or her medication and showed only a weak relationship with smoking cessation treatment outcome.

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Perhaps different results would have been obtained in an older sample of smokers, for whom memory problems could be a greater contributor to medication nonadherence.

Several studies using measures other than the MAQ have reported findings with regard to intentional versus unintentional nonadherence. George, Kong, Thoman, and Stewart (2005) assessed a sample of participants with chronic obstructive pulmonary disease using the Medication Adherence Report Scale. They found that less-adherent participants were more likely to intentionally alter their medication regimen either to better fit their lifestyle or based on how they were feeling. Toyoshima, Takahashi, and Akera (1997) used qualitative measures to study a sample of hypertensive patients and found that rates of both intentional and unintentional nonadherence were significantly higher in participants with poorly controlled blood pressure than in the group with well-controlled blood pressure. They also noted that, as the number of side effects increased, the rate of intentional nonadherence also increased. Using qualitative measures, Remien et al. (2003) examined a sample of participants taking medication for HIV treatment. They reported that many participants indicated that they intentionally withheld doses of medicine to ameliorate negative side effects. In sum, many investigations have shown that individuals are intentionally nonadherent to medications based on how they are feeling. Consistent with the findings of these studies, the present study found that scores on the purposeful nonadherence factor of the MAQ was related to adherence to medications. Given that this is the first study of this type in a sample of smokers trying to quit, future studies examining intentional and unintentional nonadherence with this population are warranted.

Motivation to quit smoking may have played a role in our findings. Previous studies reporting on the relationship among nicotine patch adherence, motivation, and outcome have been mixed. Alterman et al. (1999) showed that greater motivation was related to higher rates of patch use, and Jolicoeur and colleagues (2000) found that high motivation was related to quitting. However, Stapleton et al. (1995) demonstrated no association between motivation to quit and treatment outcome. It will be important for future smoking cessation studies using the MAQ to include measures that assess an individual's intent to quit smoking and their level of motivation, examining how this may relate to adherence. Perhaps, as the results of the present study suggest, carelessness or forgetfulness in taking medications does not predict whether someone would be nonadherent to medication regimens, but this carelessness and forgetfulness may have something to do with an individual's motivation to quit smoking, which may be able to predict adherence. Future studies should explore this avenue of investigation.

These study findings are limited to an investigational drug and nicotine patch use in the context of a clinical trial, and they may not generalize to other medications used for smoking cessation or to groups of smokers who do not volunteer for a clinical trial. In addition, the use of eDEM caps that display the time of the last opening is considered a more reactive measure than is the use of similar caps without such displays, and evidence indicates that this minimal intervention can significantly improve adherence to medications (Cramer & Rosenheck, 1999). The present study also used medications with once-a-day dosing, which may have minimized the potential influence of forgetting on adherence. Studies of medications with more complicated dosing requirements may yield different results, as once-daily dosing has been shown to enhance long-term adherence (Portsmouth, Osorio, McCormick, Gazzard, & Moyle, 2005). Finally, depression is a factor that may play a role in unintentional nonadherence (Martin, Williams, Haskard, & DiMatteo, 2005) related to cognitive impairments, pessimism, and withdrawal from social support. The items of the unintentional subscale are limited to forgetting and carelessness and may not capture patterns of nonadherence associated with depression. Nonetheless, these results suggest that the purposeful nonadherence factor of the MAQ may be used as an effective screening tool for medication adherence with cigarette smokers trying to quit. Given that this is the first study to investigate the MAQ with cigarette smokers, it will

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be important for future studies to continue to test the unintentional nonadherence factor with this study population.

The predictive validity of the MAQ, and in particular the purposeful nonadherence factor, may be an important finding for medical doctors and other clinicians working with individuals trying to quit smoking using medications. Given its brevity, the MAQ could be incorporated into clinical settings, either in its entirety or using only the purposeful nonadherence factor. For a patient who is classified as nonadherent based on his or her responses to this screening tool, physicians and other clinicians may be able to improve treatment outcome by educating the patient about the importance of adherence and addressing side effects proactively. It will be important for future research to investigate this possibility.

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Table 1

Sample demographics.

Characteristic	Total (*N*=385)	Placebo (*n*=93)	Active medication (*n*=292)
Age (years), *M (SD)*	45.95 (11.17)	45.86 (11.38)	45.98 (11.12)
Sex, % male	51.9	49.5	52.7
Cigarettes/day, *M (SD)*	27.70 (10.30)	27.42 (11.12)	27.78 (10.05)
Plasma cotinine (ng/ml), *M (SD)*	305.30 (125.97)	293.07 (129.68)	309.26 (124.73)
Number of years smoking, *M (SD)*	28.67 (11.09)	29.51 (11.86)	28.40 (10.84)
Fagerström Test for Nicotine Dependence score, *M (SD)*	5.05 (1.56)	4.87 (1.42)	5.12 (1.60)

Note. *M*, mean; *SD*, standard deviation. All differences nonsignificant by analysis of variance for continuous variables and chi-square for categorical variables.

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Table 2

Rotated two-factor matrix for the MAQ (*N*=379).

Item	Factor 1	Factor 2
Factor 1: Unintentional nonadherence		
1. Do you ever forget to take your medicine?	.81[a]	.00
2. Are you careless at times about taking your medicine?	.78[a]	.17
Factor 2: Purposeful nonadherence		
3. When you feel better, do you sometimes stop taking your medicine?	.29	.71[a]
4. Sometimes if you feel worse when you take the medicine, do you stop taking it?	.00	.86[a]

Note. Varimax rotation method was used.

[a]Item was assigned to the factor.