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Original Investigation

Relationship between smoking reduction and cessation among light smokers

Kolawole S. Okuyemi, M.D., M.P.H.,[1,2,3] *Janet L. Thomas, Ph.D.,*[1,3,4] *Jennifer Warren, Ph.D.,*[5] *Hongfei Guo, Ph.D.,*[6] *& Jasjit S. Ahluwalia, M.D., M.P.H.*[1,3,4]

[1] *Program in Health Disparities Research, University of Minnesota Medical School, Minneapolis, MN*
[2] *Department of Family Medicine and Community Health, University of Minnesota, Minneapolis, MN*
[3] *Center for Health Equity, University of Minnesota Medical School, Minneapolis, MN*
[4] *Department of Medicine, University of Minnesota Medical School, Minneapolis, MN*
[5] *Center for Communication and Health Issues, Rutgers, The State University of New Jersey, New Brunswick, NJ*
[6] *Division of Biostatistics, University of Minnesota School of Public Health and Clinical and Translational Science Institute, Minneapolis, MN*

Corresponding Author: Kolawole S. Okuyemi, M.D., M.P.H., *University of Minnesota Medical School, 717 Delaware Street SE, Minneapolis, MN 55414, USA. Telephone: 612-625-1654; Fax: 612-626-6782; E-mail: kokuyemi@umn.edu*

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Abstract

Introduction: To determine the smoking reduction patterns of light smokers (≤10 CPD) and whether reduction predicts future cessation.

Methods: Study is a secondary analysis of data that were derived from a 2 × 2 randomized study that assessed the efficacy of nicotine gum (vs. placebo) and counseling (motivational interviewing vs. health education) for smoking cessation among 755 light smokers. Participants were categorized into three groups based on self-reported CPD smoked at time of study enrollment compared with CPD smoked a year prior to enrollment. That is, (a) those who reduced number of cigarettes per day (CPD), (b) those who smoked the same number of CPD, and (c) those who increased their number of CPD. Sociodemographic and smoking characteristics were assessed at enrollment as well as cotinine-verified 7-day smoking abstinence rates at the Week 26 follow-up assessment. A stepwise logistic regression model to predict the probability abstinence at 26-week follow-up was also performed.

Results: Compared with a year prior to enrollment, 43.7% of participants reduced, 35.2% smoked the same, and 21.2% increased their CPD. Compared with those who smoked the same or increased their CPD, those who had reduced their CPD were older, more likely to be males, smoked fewer CPD at enrollment, initiated smoking at a younger age, and less likely to be nicotine dependent. Adjusted logistic regression showed that those who had reduced their smoking prior to enrollment were more likely to quit at Week 26 (odds ratio [*OR*] = 1.77; 95% *CI* = 1.062–2.957; $p = .029$).

Discussion: Findings suggest that reducing number of CPD smoked prior to enrolling in a clinical trial is a positive predictor of abstinence. Therefore, encouraging smoking reduction prior to attempting cessation may enhance cessation outcomes for light smokers.

Introduction

Over the past decade, there has been a remarkable change in the patterns of cigarette smoking among adults in the United States (Okuyemi, Harris, et al., 2002). Whereas the predominant pattern of smoking used to be that of daily moderate to heavy cigarette smoking, the proportion of smokers who do not smoke daily or smoke a few cigarettes a day has increased substantially (Hassmiller et al., 2003; Okuyemi, Harris, et al., 2002). There is growing interest in the tobacco control community in the population of smokers who smoke few cigarettes per day. These groups of smokers have been described by researchers using various terms, including light smokers, intermittent smokers, occasional smokers, nondaily smokers, and chippers. In keeping with our previous research (Okuyemi, Ahluwalia, et al., 2004), we will use the term "light smokers" to describe smokers who smoke 10 or fewer cigarettes/day. While the increase in proportion of light smokers among overall population of smokers is a recent phenomenon, evidence suggests that the proportion of light smokers is substantial and up to 50% or greater in certain groups, such as Latinos, Asians, Blacks, and adolescents.

Despite the increasing proportion of light smokers, the vast majority of smoking cessation research has been conducted among moderate and heavy smokers. The relative lack of research about light smoking is due in part to the view by some that light smoking is neither harmful nor addicting and that light smokers should be able to quit smoking without much difficulty (Okuyemi, Harris, et al., 2002). However, recent evidence has shown that light smokers can be nicotine dependent (Okuyemi, Pulvers, et al., 2007) and have cessation rates similar to that of moderate or heavy smokers (Ahluwalia et al., 2006). Furthermore, it is important to study light smokers because smoking few cigarettes a day has been associated with serious health consequences (Luoto et al., 2000). For example, despite smoking fewer cigarettes per day on average than Whites, Blacks have higher cotinine levels and experience disproportionately

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high rates of tobacco-related morbidity (United States Department of Health and Human Services [USDHHS], 1998).

Among heavy smokers, some studies have found that smoking reduction resulted in a decrease in some biomarkers of cigarette smoke exposure such as expired carbon monoxide, cotinine, and plasma thiocyanate (Bolliger et al., 2002; Wennike et al., 2003) but that the reduction in these biomarkers is not proportional to the reduction in smoking due to compensation and other possible factors (Joseph, Hecht, et al., 2005). However, other studies have found that smoking reduction did not result in any significant improvement in carbon monoxide, cotinine, and other clinical or biological markers of disease including white blood count, fibrinogen, forced expiratory volume (FEV1), forced vital capacity (FVC), and tobacco-specific nitrosamines (e.g., NNAL; Bolliger et al.; Joseph et al., 2008).

Researchers have also examined whether smoking reduction enhances or undermines cessation. Findings in this regard have been mixed. In the Lung Health Study (LHS), among smokers with early lung disease who wished to stop smoking, 3,923 were randomized to a special intervention of counseling and nicotine gum for smoking cessation and to bronchodilator therapy or placebo. Among the 1,722 who were still smoking at the first year follow-up, 27% smoked the same or more, 43% smoked 1%–49% fewer, and 30% smoked at least 50% fewer cigarettes per day. Greater smoking reduction at Year 1 predicted more quit attempts but not higher cessation at either Years 2 or 5 (Hughes et al., 2004). Other studies have reported findings similar to those of the LHS, finding no relationship between smoking reduction and cessation (Carpenter et al., 2003, 2004). However, in a more recent review of 19 studies (Hughes & Carpenter, 2006), researchers examined whether reduction in smoking among smokers not interested in quitting undermine or promote future smoking cessation. Sixteen of the 19 studies found that reduction was associated with greater future cessation, including the two randomized trials of reduction versus nonreduction. The authors concluded that smoking reduction increases the probability of future cessation.

However, research on smoking reduction among light smokers is limited. A cross-sectional study reported that occasional and light smokers engage in smoking reduction practices at much higher rates than moderate and heavy smokers (Okuyemi, Richter, et al., 2002). The study included 484 Black smokers classified as occasional, light, moderate, and heavy smokers. Researchers examined sociodemography, smoking characteristics, and eight smoking reduction strategies, including intentional limiting of smoking, smoking less than half of a cigarette, setting a daily limit for smoking, changing cigarette brand, reducing number of cigarettes, smoking only on some days, switching to a lighter tar cigarette, and not inhaling deeply. Compared with moderate and heavy smokers, occasional and light smokers were more likely to have engaged in most of these strategies. Smokers who engage in four or more these strategies on average smoked significantly fewer cigarettes per day compared with smokers who used fewer or none of these strategies. Authors concluded that smokers who engaged in multiple smoking reduction strategies smoked fewer cigarettes per day and suggested that smokers not interested in quitting but willing to reduce their smoking should be encouraged to utilize a variety of smoking reduction strategies. However, whether smoking reduction facilitates or reduces cessation among light smokers has not been studied.

To examine the association between smoking reduction and cessation among light smokers, we analyzed data from a clinical trial that assessed the efficacy of nicotine gum (vs. placebo) and counseling (motivational interviewing [MI] vs. health education [HE]) for smoking cessation among 755 Black light smokers. We hypothesized that light smokers who reduced their smoking prior to study enrollment will (a) report a higher rate of utilizing smoking reduction strategies and (b) have significantly higher abstinence rates compared with smokers who did not reduce their smoking.

Methods

Study setting and participants

Details of the study design, methodology, and smoking abstinence outcomes for the primary study are presented in detail elsewhere (Ahluwalia et al., 2006; Okuyemi, Cox, et al., 2007). Briefly, the primary study was a double-blind, placebo-controlled randomized trial of Black light smokers conducted at a community-based health center serving a predominately Black population. The study used a 2×2 factorial design in which 755 (~189 in each arm) Black light smokers were randomly assigned to one of four study arms: 8-week treatment with placebo gum plus six HE sessions, 8-week treatment with placebo gum plus six MI counseling sessions, 8-week treatment with nicotine gum plus six HE sessions, or 8-week treatment with nicotine gum plus six MI counseling sessions. In addition to gum and counseling, participants in all four arms received a culturally sensitive smoking cessation guide developed specifically for Black light smokers. Participants completed follow-up assessment and cotinine verification at 26 weeks after randomization. The study procedures were approved and monitored by the human subjects committee at the institution where study was conducted. Recruitment for the study started in March 2003 and ended in June 2004. To be eligible for the clinical trial, participants were required by self-report to be Black, be 18 years of age or older, smoke $\leq$ 10 cigarettes/day for at least 6 months prior to enrollment, smoke cigarettes on $\geq$25 of the last 30 days, be interested in setting a quit date within 14 days from screening, and have a home address and functioning telephone number. A total of 755 participants enrolled in the study.

Baseline measures

Demographic variables. These included age, gender, marital status, income, education, employment, and body mass index. Smoking history assessment included ages of smoking first cigarette and of regular smoking, number of cigarettes smoked per day (CPD), and brand of cigarette smoked (menthol or nonmenthol).

Quitting history. This was assessed with questions derived from previous studies (Okuyemi, Ebersole-Robinson, et al., 2004), including number of serious quit attempts in the past year that lasted at least 24 hr, the duration of longest quit attempts in lifetime, and duration of most recent quit attempt. Participants were asked regarding their current smoking compared with a year prior to enrollment with the question, "compared to a year ago, do you now smoke . . . ." "Fewer cigarettes per day," "About the same number of cigarettes per day," "More

cigarettes per day," or "Was not smoking one year ago." Motivation and confidence for quitting were assessed using Likert scales (0–10) with a higher score indicating greater motivation or confidence. Nicotine dependence was assessed with the question derived from the Fagerström Test for Nicotine Dependence (Heatherton et al., 1991). "How soon after you wake up do you smoke your first cigarette? With response categories including 0–5, 6–15, 16–30, 31–60, and more than 60 min.

Smoking reduction strategies. Questions were obtained from previously published studies (Haddock et al., 1999; Hajek et al., 1995; Okuyemi, Richter, et al., 2002; Shiffman et al., 1994). Participants were asked whether or not they engage in a number of smoking behaviors with the intention of decreasing their health risks from smoking. These questions included how often they (a) limited how much they smoked and (b) smoked less than half of a cigarette. Response categories for these two questions were never, rarely, sometimes, often, and always. We also asked whether or not participants set a limit about how many cigarettes to smoke per day (yes/no response). In addition, we asked about participants' inhalation methods when smoking with the following response options: inhale deeply, inhale partly into chest, inhale as far back as throat, inhale into mouth, and do not inhale/just puff. Participants were also asked if they had ever used any of the following methods in the last year to reduce their health risk from smoking: (a) changed to a different cigarette brand, (b) decreased the number of cigarettes smoked, (c) changed to smoking only on some days, and (d) switched to a lighter tar cigarette. These four questions had a "yes/no" response options.

Biological measures. *Expired* carbon monoxide (CO) was measured using a handheld portable CO monitor (Bedfont Micro Smokelyzer, Kent, England). Serum cotinine was assessed as a biomarker of baseline tobacco use at baseline.

Week 26 follow-up measures

Abstinence. This was defined as not smoking any cigarettes for the previous 7 days. Self-reported abstinence was verified by a salivary cotinine cutoff of ≤20 ng/ml (Society for Research on Nicotine and Tobacco [SRNT], 2002).

Data analysis

Data were double entered into a Microsoft Access database and statistical analyses were performed using SAS 9.1. Categorical variables were summarized with percentages, and continuous variables were summarized by means and *SD*s. For further analysis, participants were categorized into three groups based on self-reported CPD smoked in the year prior to study enrollment compared with CPD at the time of enrollment: (a) those who reduced the number of cigarettes per day (CPD) smoked, (b) those who smoked the same number of CPD, or (c) those who increased the number of CPD smoked. Participants in these three groups were compared regarding their baseline sociodemographic and smoking-related characteristics. Participants in these three groups were also compared regarding their use of health reduction strategies. For this analysis, the health risk reduction categorical variables with more than two response options were recoded as follows: "never," "rarely," and "sometimes" were collapsed into one category, while "often" and "always" were collapsed into another category and "inhale partly into chest," "as far back as throat," "into mouth," or "don't inhale/just puff" were collapsed into one category, while "inhale deeply into chest" remained a separate category. Categorical variables were collapsed consistent with a previous study (Okuyemi, Richter, et al., 2002), to increase power of statistical tests, and for ease of interpretation of results. Chi-square test, or Fisher exact test when appropriate, was used to compare categorical variables across these three groups of smokers. Analysis of variance (ANOVA), or Kruskal–Wallis test when appropriate, was used to compare the means across groups. Two-sided p values less than .05 were considered statistically significant. If there is significant global differences for continuous variables, post-ANOVA pairwise comparisons were performed using the Tukey Honestly Statistically Significant Difference tests to preserve the overall Type I error rate.

A stepwise logistic regression model to predict the probability abstinence at 26-week follow-up was performed. For the outcome variable in this model, we collapsed the two categories of those who did not reduce their CPD prior to enrollment (either smoked the same number of CPD or smoked more CPD) into one group, while those who reduced their CPD remained a separate category. The following cutoff points were used for the stepwise procedure: $p = .05$ for entry in the models and $p = .1$ for removal from the models. Independent variables in the model include age, gender, marital status, income, age of initiating smoking, cigarettes per day smoked, quit attempts in past year lasting at least 24 hr, and time to first cigarette of the day.

Results

A total of 755 participants enrolled in the parent study. As previously reported in the main outcomes paper (Ahluwalia et al., 2006), the parent study, the 7-day quit rates for nicotine gum were no better than for the placebo group (14.2% vs. 11.1%, $p = .232$) at 6 months. However, a counseling effect emerged, with HE performing significantly better than MI (16.7% vs. 8.5%, $p < .001$). In the year prior to study enrollment, 43.7% had reduced their number of CPD smoked, 35.2% smoked the same number of CPD, and 21.2% had increased their number of CPD. Table 1 presents the demographic and smoking characteristics of participants by these three groups. Significant differences were observed for age, gender, income, cigarette per day smoked at baseline, and time to first cigarette across three groups. Compared with those who smoked the same or had increased their CPD, those who had reduced their CPD were older, more likely to be males, smoked fewer CPD at enrollment, initiated smoking at a younger age, and were less likely to smoke first cigarette of the day within 30 min of awakening.

Table 2 presents the smoking reduction strategies used by participants categorized by the three smoking groups. Significant difference was observed between the three groups for all smoking reduction strategies. Results indicated that a higher proportion of those who reduced their CPD prior to study enrollment utilized each of the eight smoking reduction strategies compared with the other two groups of smokers who did not reduce their smoking. For virtually all the smoking reduction strategies, the proportion of those who reported using each of the strategies was highest for smokers reduced their CPD prior to enrollment.

Results of the logistic regression analysis predicting smoking abstinence at 26-week follow-up is shown in Table 3. Results

Table 1. Demographic and Smoking Characteristics

Characteristics	Now smoke less CPD	Smoked about the same CPD	Now smoke more CPD	*p* value
Participant age in years, mean (*SD*)	47.15 (11.01)	44.89 (9.56)	41.56 (10.56)	<.001
Gender, % (*n*) female	62.2 (202)	65.5 (171)	79.0 (124)	<.001
Age of regular smoking in years, mean (*SD*)	20.43 (6.50)	21.26 (7.11)	22.45 (7.18)	.010
Married/SO, % (*n*)	40.0 (130)	39.5 (103)	29.5 (46)	.062
Education, <HS, % (*n*)	18.2 (59)	13.0 (34)	19.1 (30)	.155
Household income < $1,800/mo % (*n*)	64.6 (206)	52.6 (131)	58.7 (91)	.016
Baseline CPD, mean (*SD*)	6.98 (2.93)	7.82 (2.92)	8.37 (3.75)	<.001
Baseline motivation (1–10 scale), mean (*SD*)	9.1 (1.6)	9.0 (1.7)	9.0 (1.8)	.313
First cigarette, % (*n*) within 30 min	61.9 (200)	64.4 (168)	73.9 (116)	.033
24-hr quit attempts in past year, mean (*SD*)	3.74 (7.75)	3.22 (6.70)	2.32 (3.18)	.090
Expired carbon monoxide in ppm, mean (*SD*)	13.9 (8.7)	13.5 (8.9)	14.6 (9.7)	.302
Baseline serum cotinine in ng/ml, mean (*SD*)	244.1 (135.0)	229.3 (152.4)	260.1 (150.5)	.133

showed that receiving HE counseling (*OR* = 2.58; 95% *CI* = 1.56–4.26) and reducing the number of cigarettes smoked prior to study enrollment (*OR* = 1.77; 95% *CI* = 1.02–2.96; *p* = .029) independently increased the odds of quitting smoking. Being older (*OR* = 0.97; 95% *CI* = 0.95–0.99; *p* = .031) or female (*OR* = 0.59; 95% *CI* = 0.36–0.97) reduced the odds of abstinence.

Discussion

The purpose of this study was to examine the association between smoking reduction, including use of various reduction strategies and cessation among Black light smokers. The main finding from the study was that those who reduced their CPD smoked ("reducers") prior to enrollment in the study were more likely to have quit smoking at 26-week follow-up when compared with those who did not reduce ("nonreducers") their smoking. This finding makes additional contribution to the literature beyond our previous research (Okuyemi, Richter, et al., 2002) because it establishes temporal relationship between smoking reduction and cessation unlike our previous report of cross-sectional findings. Although the finding of positive association between smoking reduction and future cessation among light smokers is consistent with some studies conducted among moderate and heavy smokers, we are not aware of any published work examining this topic among light smokers, in particular, Blacks. A review of 19 studies that examined whether reduction in smoking among smokers not interested in quitting undermines or promotes future smoking cessation reported that 16 of the 19 studies showed that reduction was associated with greater future cessation (Hughes and Carpenter, 2006). However, some studies (Carpenter et al., 2003, 2004) including the LHS (Hughes et al., 2004) had different findings. In the LHS, researchers found that greater smoking reduction at Year 1 predicted more quit attempts but not higher cessation in future years (Hughes et al.).

Why would light smokers who reduced their CPD prior to enrolling in a cessation clinical trial be more successful at quitting smoking? A number of factors may explain this finding. First, it is possible that reducers were either more motivated to quit or more actively engaged in trying to quit smoking prior to study enrollment compared with nonreducers. Although there were no differences in motivation scores between reducers and nonreducers, we found that reducers made marginally more 24-hr quit attempts in the past year compared with nonreducers. The lack of differences in the motivation scores between reducers and nonreducers could be due to the eligibility requirement that participants be interested in quitting within 2 weeks or enrollment, as reflected in the high mean motivation score for entire study sample of 9.1 (on a 1–10 scale).

Furthermore, study data showed that reducers utilized smoking reduction strategies at much higher rates than nonreducers. It is also possible that reducers were less nicotine dependent than nonreducers because reducers smoked fewer CPD

Table 2. Health Risk Reduction Strategies

Characteristics	Now smoke less CPD	Smoked about the same CPD	Now smoke more CPD	*p* value
Try to limit how much you smoke, % often/always (*n*)	51.4 (167)	33.0 (86)	30.6 (48)	<.001
Smoke less than half a cigarette, % yes (*n*)	42.8 (139)	34.1 (89)	24.8 (39)	<.001
How do you inhale?, % (*n*)				.052
Just puff/do not inhale	8.6 (28)	5.4 (14)	3.2 (5)	
Inhale into mouth, throat, or chest	91.4 (296)	94.6 (246)	96.8 (152)	
Set a daily limit of CPD, % yes (*n*)	61.5 (200)	38.3 (100)	33.1 (52)	<.001
Reduced CPD, % yes (*n*)	80.0 (260)	37.2 (97)	33.1 (52)	<.001
Smoke only on some days, % yes (*n*)	13.5 (44)	8.4 (22)	7.0 (11)	.039
Switched to lighter cigarette, % yes (*n*)	31.5 (102)	21.1 (55)	22.4 (35)	.009
Changed cigarette brand, % yes (*n*)	33.2 (108)	22.6 (59)	26.1 (41)	.015

Table 3. Logistic Regression Predicting Cotinine-Verified Abstinence at 26-week follow-up

Characteristics	*OR* (95% *CI*)	*p* value
Age, each year	0.973 (0.948–0.997)	.031
Gender		.035
Male	Reference	
Female	0.593 (0.363–0.968)	
Drug		.134
Placebo	Reference	
Gum	1.44 (0.893–2.332)	
Counseling		<.001
Motivational interviewing	Reference	
Health education	2.581 (1.562–4.264)	
Current smoking		.029
Now smoke about the same or more CPD	Reference	
Now smoke less CPD	1.772 (1.062–2.957)	

Note. Other variable in model but not statistically significant in the final model include age of regular smoking, marital status, income, cigarettes per day smoked, quit attempts in past year, and time to first cigarette of the day.

and less likely to smoke their first cigarette within 30 min of awakening compared with nonreducers. However, these measures of dependence were not retained in the adjusted logistic regression as predictors of cessation.

Study data also showed that a substantial proportion (43.7%) of smokers in the study reduced their number of cigarettes smoked per day prior to enrolling in the smoking cessation clinical trial. Reducers were more likely to be older, male, smoked fewer CPD at enrollment, initiated smoking at a younger age, and were less likely to smoke first cigarette of the day within 30 min of awakening. Several of these differences in the demographic and smoking-related variables are similar to what was reported in a study among heavy smokers (Joseph, Bliss, et al., 2005). That study analyzed baseline biochemical and characteristics of 152 patients enrolled in a clinical trial to investigate predictors of spontaneous reduction prior to study enrollment. Researchers found that reducers were more likely to be males, smoke fewer CPD at enrollment, and less nicotine dependent compared with nonreducers.

It therefore seems that similar factors were found to be associated with smoking reduction in their study with heavy smokers and the current study with light smokers, with light smokers behaving similar to heavier smokers. This would suggest one of two scenarios, which are either majority of the light smokers in our study were former heavy smokers or that light smokers practice smoking reduction in a similar fashion to heavy smokers. With regards to whether these light smokers were former heavy smokers, the study data show that participants are "stable" light smokers in that they have been light smokers for an average of 12 years. Having a cohort of stable light smokers is probably a reflection of the study's eligibility requirement that required that participants must have smoked at their current level for a minimum of 6 months prior to enrollment. It is therefore more likely that light smokers practice smoking reduction in a similar fashion to heavy smokers.

Current study has some limitations. First, the study was a secondary analysis of data collected for a different purpose; therefore, available data are limited to what was collected in the original study. Second, all data on smoking behavior and history are self-report, which is subject to bias. This is especially so because participants were asked to remember their smoking in the year prior to enrollment. It would be useful for future studies to further validate measure used to assess smoking patterns prior to study enrollment, for example, using test–retest procedures. Also, participants were required to be willing to quit in the next 2 weeks; therefore, results may not generalize to a population of less motivated smokers. Despite these limitations, results from this study provide initial evidence, suggesting that light smokers who reduce their smoking prior to enrolling in a clinical trial have higher likelihood of quitting smoking than those who did not reduce their smoking. Given the increasing prevalence of light smoking in the general population and limited knowledge about effective interventions, it is critical to continue efforts for enhancing cessation outcomes for light smokers. If findings from current study can be replicated, smoking reduction prior to cessation may be an additional tool for encouraging smokers to enhance their cessation outcomes.

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Declaration of Interests

Authors have no relevant conflict of interest to declare. GlaxoSmithKline provided study medication but played no role in the design, conduct of the study, or interpretation and analysis of the data. None of the authors have received any funding, direct or indirect, and none have any connection with the tobacco, alcohol, or gaming industries or any body substantially funded by one of these organizations. One of the authors has served as consultant to a pharmaceutical company that is not connected with current study.

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