Journal of the American College of Cardiology Vol. 56, No. 25, 2010

Published by Elsevier Inc.

ISSN 0735-1097/$36.00
doi:10.1016/j.jacc.2010.07.031

Effectiveness of a Smoking Cessation Program for Peripheral Artery Disease Patients

A Randomized Controlled Trial

Deborah Hennrikus, PhD,* Anne M. Joseph, MD, MPH,† Harry A. Lando, PhD,* Sue Duval, PhD,* Laurie Ukestad, MS,‡ Molly Kodl, PhD,§ Alan T. Hirsch, MD*†

Minneapolis, Minnesota

Objectives This study tested the effectiveness of a smoking cessation program designed for patients with peripheral artery disease (PAD).

Background Tobacco use is the leading risk factor for PAD incidence and progression and for ischemic events. Tobacco cessation reduces PAD-related morbidity and mortality, yet few prospective clinical trials have evaluated smoking cessation interventions in PAD patients.

Methods We recruited outpatients with lower extremity PAD identified from medical records as cigarette smokers. Participants were randomly assigned to an intensive tailored PAD-specific counseling intervention or a minimal intervention. Participants completed surveys at baseline and at 3- and 6-month follow-up. Reported 7-day point prevalent smoking abstinence was confirmed by cotinine or carbon monoxide assessment.

Results In all, 687 outpatients were identified as probable smokers with lower extremity PAD; 232 met study eligibility requirements; and 124 (53% of eligible) enrolled. Participants were receptive to counselor contact: the median number of sessions was 8.5 (range 0 to 18). Participants randomly assigned to the intensive intervention group were significantly more likely to be confirmed abstinent at 6-month follow-up: 21.3% versus 6.8% in the minimal intervention group (chi-square = 5.21, p = 0.023).

Conclusions Many long-term smokers with PAD are willing to initiate a serious quit attempt and to engage in an intensive smoking cessation program. Intensive intervention for tobacco dependence is a more effective smoking cessation intervention than minimal care. Studies should be conducted to examine the long-term effectiveness of intensive smoking cessation programs in this population to examine the effect of this intervention on clinical outcomes related to PAD. (J Am Coll Cardiol 2010;56:2105–12) © 2010 by the American College of Cardiology Foundation

Atherosclerotic peripheral arterial disease (PAD) is a highly prevalent disorder that affects between 5% and 10% of U.S. adults >40 years of age (1–3). PAD is a major cause of disability in many persons. It often decreases functional capacity because of exercise-associated limb pain (claudication) and, if untreated, may progress to critical limb ischemia, defined as ischemic rest pain, gangrene, or amputation (4,5).

Cigarette smoking is the single most important risk factor for the development and progression of PAD (1,2,6,7). A meta-analysis of 17 studies found a 2.2-fold greater prevalence of symptomatic PAD in smokers compared with nonsmokers (7). Continued smoking accelerates the progression of stable claudication to more serious limb ischemic PAD syndromes, including critical limb ischemia, and to fatal and nonfatal systemic cardiovascular ischemic events (e.g., angina, myocardial infarction, transient ischemic attack, and stroke). PAD patients who achieve abstinence from smoking have far higher survival rates than those who do not (8–10).

See page 2113

Despite the importance of quitting smoking for persons with PAD, few studies have examined smoking cessation in PAD patients, and most that have been conducted have

From the *Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, Minneapolis, Minnesota; †Medical School, University of Minnesota, Minneapolis, Minnesota; ‡Division of Environmental Health Sciences, School of Public Health, University of Minnesota, Minneapolis, Minnesota; and the §Veterans Administration Medical Center, Minneapolis, Minnesota. This project was supported by funds from ClearWay Minnesota, Bloomington, Minnesota (Grant No. RC-2005-0039). Dr. Duval has received a research grant from Abbott Vascular. All other authors have reported that they have no relationships to disclose.

Manuscript received March 31, 2010; revised manuscript received June 25, 2010, accepted July 6, 2010.

JACC Vol. 56, No. 25, 2010
December 14/21, 2010:2105–12

Abbreviations and Acronyms

PAD = peripheral arterial disease

VAMC = Veterans Administration Medical Center

been observational studies in which no formal smoking cessation program was provided (11,12). One randomized study has been conducted: Galvin et al. (13) tested the effectiveness of nurse-conducted smoking cessation education program and the use of nicotine gum, a pharmacological aid for smoking cessation, but the sample size was very small and the end point was smoking reduction rather than smoking cessation. This study found a significant difference between the intervention and control groups in self-reported number of cigarettes smoked, but tests of 2 biomarkers of tobacco use, expired carbon monoxide and urinary cotinine, a metabolite of nicotine, provided conflicting results (13).

The present study tested the reach and effectiveness of an intensive, comprehensive smoking cessation program for PAD patients. A first objective was to examine the willingness of PAD patients to enroll in an intensive program. The second objective was to examine program effectiveness: we hypothesized that the 7-day point prevalence of abstinence would be significantly higher among patients randomly assigned to an intensive PAD-specific intervention condition compared with patients randomly allocated to a minimal intervention (usual care) control group.

Methods

Sites and participants. Participants were recruited from 2 medical centers in Minneapolis, Abbott Northwestern Hospital and the Minneapolis Veterans Administration Medical Center (VAMC). All participants provided written informed consent, and the study was approved by institutional review boards at the University of Minnesota, the VAMC, and the Allina Health System.

Primary inclusion criteria were a diagnosis of lower extremity PAD (defined as at least 1 of the following: an ankle-brachial index of <0.90 in at least 1 lower extremity; toe brachial index of <0.60; objective evidence of arterial occlusive disease in 1 lower extremity by duplex ultrasonography, magnetic resonance angiography or computed tomographic angiography; prior leg arterial revascularization or amputation due to PAD; and current smoking [defined as smoking at least 1 cigarette a day at least 6 days per week]). Additional inclusion criteria included a desire to quit within the next 30 days, age 18 years or older, ability to speak and write English, no participation in a smoking cessation program in the past 30 days, and consumption of fewer than 21 alcoholic drinks per week.

Procedures. Between July 2006 and May 2008, study staff identified potentially eligible patients who were scheduled for upcoming visits at the recruitment sites from appointment lists and electronic medical records. We sent patients letters describing the study and screened them either by telephone before an upcoming medical appointment or in person at the visit to determine eligibility for the study. Interested and eligible patients underwent the informed consent process with the study coordinator at the clinic visit and completed a baseline survey. We randomized participants using a predetermined block randomization schedule stratified by medical center to either the intensive smoking cessation intervention group or to the minimal intervention group.

Follow-up surveys were mailed to participants 3 months and 6 months after baseline survey completion. We mailed a second copy of the survey with a reminder letter to participants who had not returned the initial copy. If the survey was still not returned, we contacted the participant by telephone to request survey completion. At the 6-month follow-up, we sent participants who did not return the survey after these contacts a 1-page version of the survey that measured the smoking outcome only. Participants reporting abstinence from cigarettes at 6 months were asked either to provide a saliva sample to test for cotinine (a metabolite of nicotine) or, if they were using nicotine replacement products, to provide an expired air sample to test carbon monoxide levels to verify self-report. Saliva was collected by mail; we mailed a second saliva collection kit to participants who did not return a saliva sample within 9 to 12 days after the initial mailing. This method of collecting saliva samples for biochemical verification has been used in previous studies (14). We conducted carbon monoxide testing in person, generally at the participant's home.

Intervention. INTENSIVE INTERVENTION GROUP. The intensive smoking cessation intervention included both physician advice to quit smoking and smoking cessation counseling provided by a study counselor. Vascular clinic care providers were cued to provide cessation advice by a prompt in participants' medical charts. In addition, we sent participants in the intensive intervention group an individualized letter from a vascular healthcare provider at the site where they were receiving care advising them to quit smoking and emphasizing the importance of quitting for patients with PAD.

The counseling intervention included behavioral and pharmacological components that are evidence-based in the general population of smokers. Counseling consisted of a combination of education about the link between smoking and the onset and progression of PAD, motivational interviewing to increase motivation to quit (15), cognitive-behavioral counseling to develop a quit plan (16), and provision of information about pharmacological aids for smoking cessation. Counselors used a cognitive-behavioral, problem-solving skills training approach to help patients select a target quit date, prepare for quitting, and identify personally relevant behavioral and cognitive strategies for coping with urges to smoke (16). They encouraged participants to use stop-smoking medication aides and provided information about available types of medication and how to obtain them through their health insurance or their healthcare provider. They also asked patients to select a person in their social network who could actively support their quit efforts. If the patient nominated a support person and gave

permission to do so, the counselor contacted the support person by telephone early in the counseling process to discuss strategies to provide effective support to the participant.

We planned to deliver a minimum of 6 counseling sessions over a period of 5 months, but more were allowed when participants desired them. The initial visit with the counselor generally occurred in person; subsequent visits occurred either in person or by telephone, at the participant's convenience.

Counselor training for the study included education about tobacco addiction, counseling techniques, pharmacological aids for smoking cessation, and the intervention protocol; it culminated in role plays of counseling situations. We conducted monthly meetings with counselors throughout the study to discuss individual cases.

MINIMAL INTERVENTION GROUP. As in the intensive condition, participants in the minimal intervention received verbal advice to quit smoking from their vascular provider prompted by a form in the medical chart. The study coordinator gave participants in this group a list of smoking cessation programs and resources in their community. These participants did not receive a letter from a vascular provider encouraging them to quit smoking nor did they meet with a study smoking cessation counselor.

Measures. SMOKING STATUS. The primary tobacco use outcome measure was 7-day point prevalence of smoking (i.e., "Have you smoked a cigarette, even a puff, in the past 7 days?") (17), at the 3-month and the 6-month follow-up. At the 6-month follow-up, saliva samples were tested using NicAlert test strips (Nymox Corporation, Hasbrouck Heights, New Jersey). NicAlert levels of 1 or more (i.e., >10 ng/ml) were considered disconfirming values. Carbon monoxide levels ≥8 ppm were considered indicative of smoking. Persons who did not provide a self-report of smoking status (i.e., were lost to follow-up) or for whom biochemical verification of smoking status could not be obtained were classified as smokers.

USE OF PHARMACOLOGICAL AIDS FOR SMOKING CESSATION. On each survey, participants were asked whether they had used each of 7 medications that are the most commonly used pharmacological aids for smoking cessation: the nicotine patch, nicotine gum, nicotine lozenge, nicotine inhaler, nicotine nasal spray, bupropion hydrochloride (Zyban), and varenicline (Chantix). Participants were asked whether they had ever used these medications and whether they used these medications between study enrollment and the 6-month follow-up, and, if so, for how many days.

OTHER SMOKING-RELATED MEASURES. Measures of smoking history, current attitudes and practices related to smoking, and social context of smoking were administered at baseline. These measures included number of cigarettes smoked per day (daily smokers) or per week (nondaily smokers); age of initiation of smoking; level of addiction to nicotine (18), previous participation in a formal smoking cessation program; reduction of smoking and the number of quit attempts lasting at least 24 h in the previous year; and level of self-efficacy for cessation measured by a single item that asked participants to rate on a scale from 0 to 10 their confidence that they could quit permanently if they decided to do so. Questions about participant beliefs included 4 items adapted from a number of sources (19–21) that evaluated the subject's level of concern about PAD ("I am concerned about my circulation problems/peripheral artery disease"); PAD-specific risk of smoking ("My circulation problems are not related to cigarette smoking" and "Continued smoking would seriously harm my long-term health"); and the importance of quitting ("With the health problems I have, I really need to quit smoking now"). Response options for these questions were strongly disagree, disagree, agree, or strongly agree. Measures of the social context of smoking were the number of other smokers in the subject's household; smoking status of the spouse or partner; the number of close friends who smoke (response options: almost all, more than half, about half, less than half, almost none, none); and perceived level of support for quitting smoking measured separately for family and friends (response options: a scale of 1 to 5, where 1 means "not at all supportive" and 5 means "extremely supportive").

DEMOGRAPHIC AND HEALTH-RELATED MEASURES. Demographic characteristics measured at baseline included age, sex, ethnicity, marital status, and education level. Health-related measures included a measure of depression, the 10-item version of the Center for Epidemiological Studies Depression Scale (CES-D) (22) and a Short Form (36) Health Survey (SF-36) item questionnaire that measures the subject's perception of his/her general health (response options: excellent, very good, good, fair, poor) (23).

Intervention process. The study counselors recorded the number of counseling sessions completed and the length and site of each session.

Analyses. We first examined differences between the study groups for factors that could be potential confounders in the main outcome analysis, using *t* tests for continuous variables and chi-square tests for categorical variables. The variables tested are listed in Table 1. Because we found no differences between the groups on potential confounders, we used chi-square to test the relationships between study group and smoking status at follow-up and use of pharmacological aids for smoking cessation during the study period. Analyses of follow-up smoking status were intent to treat: participants who were lost to follow-up (self-report and validated measures) or who did not provide samples to validate self-report of abstinence (validated measure) were considered smokers. We did not adjust alpha levels to account for testing at both 3- and 6-month follow-up.

Results

Figure 1 provides an overview of recruitment, eligibility, and survey completion. Of the 687 participants who were identified from records as patients with PAD who were

JACC Vol. 56, No. 25, 2010
December 14/21, 2010:2105–12

Table 1 PAD Tobacco Study Baseline Characteristics of Intensive Intervention Group and Minimal Intervention (Control) Group

	Intensive Intervention (n = 64)	Minimal Intervention (n = 60)	Test of Difference Between Groups p Value
Site			0.91
Abbott Northwestern	23 (36)	21 (35)	
VAMC	41 (64)	39 (65)	
Sociodemographic characteristics			
Mean (SD) age	59.8 (7.1)	60.7 (9.0)	0.53
Sex			0.38
Male	53 (83)	53 (88)	
Female	11 (17)	7 (12)	
Race			0.27
White	58 (92)	58 (97)	
Other	5 (8)	2 (3)	
Education			0.33
High school degree or less	18 (28)	17 (28)	
Vocational training or some college	38 (59)	40 (67)	
College or university undergraduate or graduate degree	8 (13)	3 (5)	
Marital status			0.29
Married or living together	27 (42)	31 (52)	
Not married	37 (58)	29 (48)	
General health			
Depression (CES-D-10 total score ≥10)	19 (32)	15 (28)	0.61
General health judged fair or poor (SF-36 item)	34 (54)	32 (54)	0.98
Tobacco-related variables			
Mean (SD) age of starting smoking	15.7 (3.5)	15.8 (3.3)	0.87
Mean (SD) cigarettes per day	18.8 (10.7)	17.5 (12.8)	0.74
First cigarette of morning within 30 min of waking	59 (92)	53 (88)	0.47
Mean confidence can quit (11-point scale)	6.1 (2.6)	6.4 (2.5)	0.53
Believe that his/her PAD is related to smoking (agree or strongly agree)	45 (74)	41 (72)	0.82
Believe that continued smoking would seriously harm his/her long-term health (agree or strongly agree)	59 (97)	57 (97)	0.38
Cut back smoking in past year	44 (69)	39 (65)	0.66
One or more quit attempt in past year	47 (73)	39 (65)	0.31
Previous participation in a quit program	16 (25)	9 (15)	0.17
Previous use of some type of NRT (patch, gum, lozenge, inhaler, or nasal spray)	52 (81)	52 (87)	0.41
Previous use of bupropion	30 (47)	26 (44)	0.76
Previous use of varenicline	11 (20)	14 (27)	0.40
Any other smokers in household	28 (65)	28 (62)	0.78
Spouse smokes	17 (27)	15 (25)	0.55
Number of close friends who smoke			0.61
Almost all	13 (20)	14 (24)	
Some	35 (55)	27 (46)	
None or almost none	16 (25)	18 (31)	
Perceived support for quitting from family			0.20
Extremely supportive	39 (65)	44 (76)	
Somewhat supportive	14 (23)	12 (21)	
Not supportive	7 (12)	2 (3)	
Perceived support for quitting from friends			0.48
Extremely supportive	30 (48)	25 (45)	
Somewhat supportive	23 (37)	26 (46)	
Not supportive	9 (15)	5 (9)	

Results are expressed as n (%) or mean (SD).

CES-D = Center for Epidemiologic Studies Depression Scale; NRT = nicotine replacement therapy; SF-36 = Short Form (36) Health Survey; VAMC = Veterans Administration Medical Center.

current smokers, 583 (85%) were screened for eligibility, and 232 (34% of those identified and 40% of those screened) met all eligibility criteria for the study. Fifty-three percent of those eligible for the study consented to participate. Among confirmed smokers, the most common reason for ineligibility was not wanting to quit in the next 30 days (n = 171). If these 171 patients are included in a calculation of the proportion of confirmed smokers interested in quitting

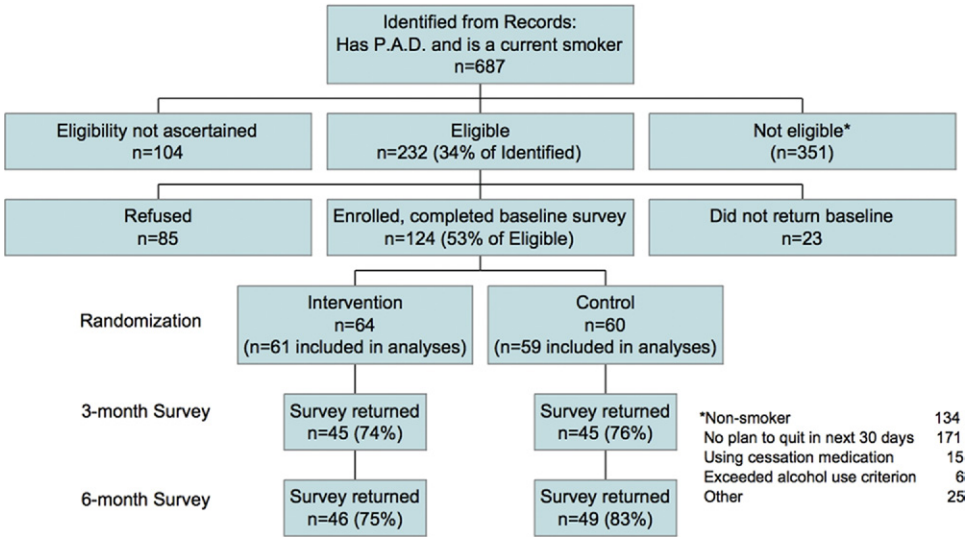

Figure 1 **Diagram of Recruitment, Randomization, and Survey Return Rates**

Of patients identified from records as diagnosed with peripheral artery disease (PAD) and smokers and screening for study eligibility, 232 (40% of those screened) met all eligibility criteria for the study. Fifty-three percent of those eligible consented to participate; 64 were randomly allocated to the intensive intervention group and 60 to the minimal intervention group. Survey completion rates for the 2 groups were similar at 3-month follow-up, but the completion rate of the minimal intervention group was higher at 6-month follow-up than that of the intensive group (83% vs. 75%).

immediately, 31% of confirmed smokers (124 of 403) indicated interest in quitting immediately.

Of the 124 enrolled in the study, 64 were randomized to the intensive intervention group and 60 to the minimal intervention group. Four participants who died during the course of the study (3 in the intensive intervention group and 1 in the minimal intervention group) were not included in computation of survey completion rates or analyses of study outcomes. Survey completion rates for the 2 groups were similar at 3-month follow-up, but the completion rate of the minimal intervention group was higher at 6-month follow-up than that of the intensive group (83% vs. 75%).

Participant characteristics. Table 1 presents characteristics of the participants and displays differences at baseline between the intensive and minimal intervention groups. Participants were predominantly male (85%) and Caucasian (94%); the mean age was 60 years (range 40 to 81 years). They smoked a mean number of 20 cigarettes per day, and 90% smoked their first cigarette of the day within 30 min of waking. These data suggest that most of the participants had a high level of nicotine dependence. Reponses to questions about beliefs concerning smoking indicated that almost all of the participants believed that smoking posed a risk to health and that it was important for their health to quit smoking immediately. The majority of participants had tried to quit and had cut back on smoking during the past year and most had used pharmacological aids for smoking cessation, but only 20% had ever participated in a formal smoking cessation program. Most were not confident that they could quit smoking. The majority of participants lived with other smokers and had close friends who smoked. They reported that their family members were extremely supportive of their quitting smoking, but indicated that they had less support from friends. Finally, one-half of participants reported only fair or poor health and a relatively large proportion (30%) scored as depressed on the CES-D-10. We found no significant baseline differences in these variables between participants randomly assigned to the intensive and minimal intervention groups.

Intervention fidelity. Participants were receptive to counselor contact: only 2 could not be contacted for counseling, and the median number of sessions was 8.5 (range 0 to 18). Twenty-six percent of sessions were completed in person; the remainder was completed by phone. Median length of sessions was 20 min. The median total time for counseling sessions per patient was 3.2 h, but the total time was quite variable ranging from 20 min to 10.8 h among the patients who were reached for counseling.

Medication use. Table 2 describes differences between the intensive and minimal intervention groups in the use of pharmacological aids for smoking cessation during the study period as reported on the 6-month follow-up survey. Intensive intervention group participants reported significantly more use of pharmacological aids for smoking cessation during the study period. At 6-month follow-up, 87% of intensive intervention group participants reported using pharmacological aids for smoking cessation during the period between the baseline and 6-month surveys whereas 67% of minimal intervention participants did so ($p = 0.024$). Among those who used medications, the proportion

Table 2 Percentage of Participants Who Reported Use of Pharmacologic Aids for Smoking Cessation During Study Period on 6-Month Survey (n = 95)

	Intervention (n = 46)	Control (n = 49)	Chi-Square	p Value
Used any medication	87.0	67.4	5.127	0.024
Used nicotine replacement medication	45.6	32.7	1.686	NS
Used bupropion	8.7	20.4	2.590	NS
Used varenicline	54.4	30.6	5.484	0.019

Note: 29 participants who did not complete the 6-month survey could not be included in analyses; 25 (15 in the intensive intervention group and 10 in the minimal intervention group) did not return the survey and 4 died before the survey.

who used nicotine replacement products was roughly similar between the 2 groups, but intensive intervention participants were significantly more likely to have used varenicline (54.4% vs. 30.6% in the minimal intervention group, p = 0.019). The median number of days of reported medication use for those who used medication was 47.5 for intensive intervention participants and 13.0 for minimal intervention participants.

Smoking abstinence. Table 3 presents 7-day point prevalent abstinence at 3- and 6-month follow-up. Intent-to-treat self-report data are provided for both follow-up periods and biochemically verified results are provided for the final follow-up. Participants lost to follow-up and therefore counted as smokers numbered 30 at 3-month follow-up (16 in the intensive group and 14 in the minimal group) and 25 at 6-month follow-up (15 in the intensive group and 10 in the minimal group). Of the participants who reported abstinence on the 6-month follow-up survey, 4 (2 in each condition) did not provide samples for biochemical confirmation, and the reports of 5 (3 in the intensive condition and 2 in the minimal condition) who did provide samples were not confirmed by the biochemical tests. These participants were also counted as smokers in analyses.

At 6-month follow-up, intensive intervention participants were significantly more likely to be abstinent than minimal intervention participants: verified quit rates at 6-month follow-up were 21.3% in the intensive intervention group versus 6.8% in the minimal intervention group (chi-square = 5.21, p = 0.023). This effect was evident at both of the study sites: verified quit rates for minimal and intensive groups were 4.8% versus 13.7%, respectively, at Abbott Northwestern and 7.8% versus 25.6% at the VAMC.

Discussion

The key findings of this study are that many patients with PAD who are current smokers are interested in quitting and receptive to a formal smoking cessation program, and a significant proportion can quit when provided with resources to do so. Interest in quitting was reflected in the high proportion of participants who had cut back on the amount they smoked or had tried to quit smoking in the year before the study and the fact that most participants had previously used pharmacological aids for smoking cessation. About a third of confirmed smokers in this group indicated interest in quitting smoking immediately.

Participant responses to questions on the baseline survey about their beliefs about smoking and health were also consistent with a desire to quit: study participants almost universally indicated an understanding of the risk of smoking to their health and the need to quit immediately. Finally, the desire to quit was demonstrated by the high level of engagement in counseling among those assigned to the intensive intervention condition. These data reinforce the importance of providing critical resources to these "at risk" but highly motivated patients.

These patients with PAD were confronted with considerable obstacles to smoking cessation including high levels of addiction to smoking. For example, 90% of participants in this study reported smoking the first cigarette of the day

Table 3 Relationship Between Study Condition and Abstinence at 3- and 6-Month Follow-Up

Group	n	Abstinent n (%)	Chi-Square	p Value
3-month follow-up: self-report intent-to-treat analysis				
Intensive	61	13 (21.3)		
Minimal	59	4 (6.8)	5.21	0.023
6-month follow-up: self-report intent-to-treat analysis				
Intensive	61	19 (31.2)		
Minimal	59	6 (10.2)	8.00	0.005
6-month follow-up: biochemically verified intent-to-treat analysis				
Intensive	61	13 (21.3)		
Minimal	59	4 (6.8)	5.21	0.023

Note: 4 participants who died before the 6-month survey were excluded from analyses.

within 30 min of waking compared with 50.8% of Minnesota smokers in the 2006/2007 Tobacco Use Supplement to the Current Population Survey (24). The mean number of cigarettes per day smoked by participants was 21.2, compared with the mean of 13.9 cigarettes per day reported by Minnesota smokers in the Current Population Survey (24). In addition, the majority of participants lived in households with other smokers and many had spouses or partners who smoked, so were probably exposed to daily cues for smoking.

The results of this study suggest that providing intensive smoking cessation intervention for patients with PAD can significantly increase short-term quit rates. This effect may be due to increased use of medications by patients in the intensive intervention group, receipt of counseling, or both. Intensive intervention participants were significantly more likely to use pharmacological aids for smoking cessation, and, if they did use them, to use them for a longer period of time. Participants in the intensive intervention group were also significantly more likely to use varenicline, the newest of the medications available for smoking cessation. The smoking cessation literature reports a reluctance of many smokers to try pharmacological aids for smoking cessation and, among those who do try it, frequent failure to use it long enough or in sufficient quantity (25,26). One benefit of more intensive counseling may be to encourage patients to start and persevere in the use of pharmacological aids for smoking cessation.

Study limitations. The study results must be interpreted in light of methodological limitations. Participants were recruited from 2 large medical centers that provide specialty care for patients with PAD. It is possible that this patient population is not representative of all patients with PAD, such as those primarily managed in primary care. Other important limitations are the short time frame of the study, since relapse can occur after 6 months, and that we did not include a measure of more prolonged abstinence. Information about medication use might have been inaccurate, since it was based on recall of use over a 3-month period on the follow-up surveys.

Despite these limitations, these results have implications for both medical practice and research. A significant proportion of patients diagnosed with PAD and identified as current smokers in medical records was willing to initiate a serious quit attempt and participate in an intensive smoking cessation program. It is important that healthcare providers advise PAD patients to quit smoking and follow-up this recommendation with appropriate care. The effectiveness of healthcare-based interventions for smoking cessation has been well established, as reflected in the recently updated and evidence-based Public Health Service clinical practice guideline for tobacco use (27). The U.S. and international PAD evidence-based guidelines uniformly offer class I recommendations that all clinicians offer individuals with PAD a tobacco cessation intervention (28,29).

Augmentation of standard treatment might also be called for with this group of patients. Gritz et al. (30) suggest that chronically ill patients who continue to smoke after diagnosis might profit from modification and tailoring of standard smoking cessation treatment designed for healthy smokers. Patients who continue to smoke even after being diagnosed with a chronic illness that is caused and/or exacerbated by tobacco use are likely to be highly addicted to nicotine and might face problems with comorbidities and lack of access to care that are not faced by healthy smokers. Gritz et al. (30) suggest modifications of treatment for this population that go beyond increased intensity: including the family in treatment, improving access to smoking cessation programs, providing specially tailored materials, and ensuring that medical providers address tobacco use even though there are many medical and lifestyle issues that must be addressed in the treatment of patients with chronic illnesses. Research into the effectiveness of these and other modifications of smoking cessation treatment for chronically ill patients is needed.

Conclusions

Many long-term smokers with PAD are willing to initiate a serious quit attempt and to engage in an intensive smoking cessation program. Such engagement with an intensive PAD-specific intervention is associated with a significant increase in smoking abstinence. These results indicate the importance of incorporating smoking cessation treatment into the medical management of PAD. Given high levels of addiction and significant barriers to quitting in many PAD patients, treatment should include tobacco dependence management that is rigorous and long-term. Future investigation of a larger sample with longer follow-up should be conducted to evaluate the impact of this intervention on limb symptoms and systemic ischemic event rates.

Reprint requests and correspondence: Dr. Deborah Hennrikus, School of Public Health, University of Minnesota, 1300 South Second Street, Suite 300, Minneapolis, Minnesota 55408. E-mail: hennr001@umn.edu.

REFERENCES

1. Agarwal S. The association of active and passive smoking with peripheral arterial disease: results from NHANES 1999–2004. Angiology 2009;60:335–45.
2. Criqui MH. Peripheral arterial disease—epidemiological aspects. Vasc Med 2001;6 Suppl 1:3–7.
3. Hirsch AT, Criqui MH, Treat-Jacobson D, et al. Peripheral arterial disease detection, awareness, and treatment in primary care. JAMA 2001;286:1317–24.
4. McDaniel MD, Cronenwett JL. Basic data related to the natural history of intermittent claudication. Ann Vasc Surg 1989;3:273.
5. Imparato AM, Kim GE, Davidson T, Crowley JG. Intermittent claudication: its natural course. Surgery 1975;78:795.
6. Cole CW, Hill GB, Farzad E, et al. Cigarette smoking and peripheral arterial occlusive disease. Surgery 1993;114:753–7.
7. Willigendael EM, Teijink JAW, Bartelink ML, et al. Influence of smoking on incidence and prevalence of peripheral arterial disease. J Vasc Surg 2004;40:1158–65.
8. Chi UW, Jaff MR. Optimal risk factor modification and medical management of the patient with peripheral arterial disease. Catheter Cardiovasc Interv 2008;71:475–89.

9. Faulkner KW, House AK, Castleden WM. The effect of cessation of smoking on the accumulative survival rates of patients with symptomatic peripheral vascular disease. Med J Aust 1983;1:217–9.
10. Lassila R, Lepantalo M. Cigarette smoking and the outcome after lower limb arterial surgery. Acta Chir Scand 1988;154:635–40.
11. Ramirez-Tortosa MC, Urbano G, Lopez-Jurado M, et al. Lifestyle changes in free-living patients with peripheral vascular disease (Fontaine stage II) related to plasma and LDL lipid composition: a 15 month follow-up study. Clin Nutr 1999;18:281–9.
12. Smith I, Franks PJ, Greenhalgh RM, Poulter NR, Powell JT. The influence of smoking cessation and hypertriglyceridaemia on the progression of peripheral arterial disease and the onset of critical ischaemia. Eur J Vasc Endovasc Surg 1997;11:402–8.
13. Galvin K, Webb C, Hillier V. Assessing the impact of a nurse-led health education intervention for people with peripheral vascular disease who smoke: the use of physiological markers, nicotine dependence and withdrawal. Int J Nurs Stud 2001;38:91–105.
14. McBride CM, Curry SJ, Lando HA, Pirie PL, Grothaus LC, Nelson JC. Prevention of relapse in women who quit smoking during pregnancy. Am J Public Health 1999;89:706–11.
15. Miller WR, Rollnick S. Motivational Interviewing: Preparing People to Change Addictive Behavior. New York: The Guildford Press, 1991.
16. Fiore MC, Jaén CR, Baker TB, et al. Treating Tobacco Use and Dependence: 2008 update. Clinical Practice Guideline. Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, 2008.
17. Hughes JR, Keely JP, Niaura RS, Ossip-Klein DJ, Richmond RL, Swan GE. Measures of abstinence in clinical trials: issues and recommendations. Nicotine Tobac Res 2003;5:13–26.
18. Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom KO. The Fagerstrom test for nicotine dependence: a revision of the Fagerstrom tolerance questionnaire. Br J Addict 1991;86:1119–27.
19. Bloom RJ, Stevick CA, Lennon S. Patient perspectives on smoking and peripheral vascular disease, a Veteran population survey. Am Surg 1990;56:535–9.
20. Kaufert JM, Rabkin SW, Syrotuik J, Boyko E, Shane F. Health beliefs as predictors of success of alternate modalities of smoking cessation: results of a controlled trial. J Behav Med 1986;9:475–89.
21. Marshall P. "Just one more. . .!" A study into the smoking attitudes and behaviour of patients following first myocardial infarction. Int J Nurs Stud 1990;27:375–87.
22. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D. Am J Prev Med 1994;10:77–84.
23. Ware JE, Snow KK, Kosinski M, Gandek B. SF-36 Health Survey: Manual and Interpretation Guide. Boston, MA: Nimrod Press, 1993.
24. Giovino GA, Chaloupka FJ, Hartman AM, et al. Cigarette Smoking Prevalence and Policies in the 50 States: An Era of Change. The Robert Wood Johnson Foundation ImpacTeen Tobacco Chart Book. Buffalo, NY: University at Buffalo, State University of New York, 2009.
25. Etter JF, Perneger TV. Attitudes toward nicotine replacement therapy in smokers and ex-smokers in the general public. Clin Pharmacol Ther 2001;69:175–83.
26. Shiffman S, Ferguson SG, Rohay J, et al. Perceived safety and efficacy of nicotine replacement therapies among US smokers and ex-smokers: relationship with use and compliance. Addiction 2008;103:1371–8.
27. Fiore MC, Jaén CR, Baker TB, et al. Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline. Rockville, MD: U.S. Department of Health and Human Services. Public Health Service, May 2008.
28. Hirsch AT, Haskal ZJ, Hertzer NR, et al. ACC/AHA guidelines for the management of patients with peripheral arterial disease (lower extremity, renal, mesenteric, and abdominal aortic): a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines for the Management of Patients with Peripheral Arterial Disease [Lower Extremity, Renal, Mesenteric, and Abdominal Aortic]). Circulation 2006;113:1474–547.
29. Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG, for the TASC II Working Group. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). J Vasc Surg 2007;45 Suppl S:5–67.
30. Gritz ER, Vidrine DJ, Fingeret MC. Smoking cessation: a critical component of medical management in chronic disease populations. Am J Prev Med 2007;33 Suppl:414–22.

Key Words: clinical trials ■ peripheral artery disease ■ smoking cessation.