# Adding Spirometry, Carbon Monoxide, and Pulmonary Symptom Results to Smoking Cessation Counseling:

## A Randomized Trial

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***Smokers are often advised to quit in a discussion of future health risks. The authors tested whether adding information about personal effects of smoking would motivate hospital outpatients to stop smoking more than advice about potential hazards would. Ninety smokers in a general screening clinic were randomized to receive education alone or education plus an additional motivational intervention that contained immediate feedback about the smoker's exhaled carbon monoxide (CO) values, spirometry results, and pulmonary symptoms. A self-report of smoking status was obtained one, four, and 12 months after the intervention. In addition, at 12 months, exhaled CO measurements were made. Smokers who received the additional motivational intervention were more than twice as likely to report quitting some time during the 12-month follow-up (40% vs. 16%, $p = 0.015$). At 12 months, 33% of the intervention group and 10% of the control group smokers tested had achieved CO-validated cessation ($p = 0.03$). Counting all patients not contacted as continuing to smoke, the percentages were 20% vs. 7% ($p = 0.06$). These practical feedback methods to motivate cessation deserve testing in other settings. Key words: spirometry; carbon monoxide; smoking therapy; smoking psychology.*** J GEN INTERN MED 1990;5:16–22.

MOST SMOKERS who quit do so on their own rather than joining formal smoking intervention programs.[1, 2] Patients who continue to smoke constitute a recalcitrant group who may require special interventions. Since physicians and other health care professionals have contact with almost three-fourths of current smokers each year, their use of effective motivational strategies could exert a significant influence on patients to reduce smoking.[1, 3] Even with minimal contact, smoking cessation rates after physician counseling range from 5–10% in asymptomatic smokers to more than 40% in high-risk patients or those with smoking-related illnesses.[1, 4-7] In medical settings, cessation rates are highest when advice is provided by both physicians and non-physicians in an individualized, face-to-face effort that employs multiple modalities for assisting behavioral change over time.[8]

Smokers who try to stop often report a final recognition of personal susceptibility to the adverse effects of smoking or an immediate threat to their health.[5, 9] Health care providers usually attempt to motivate smoking cessation by discussing future health hazards or, in patients with established disease, by pointing out that their smoking-related symptoms are evidence of the need to quit. What can be done to personalize the health effects of smoking so individuals become motivated to quit before they experience smoking-related diseases?

Although use of personalized and immediate feedback about smoking risks and problems has been recommended to facilitate a smoker's decision to quit, few trials to test motivational tactics have been reported.[10] This project compared the effect of giving smokers information about their pulmonary status as a way of motivating them to quit with giving them standard population-based risk information.

### Motivational Interventions to Stop Smoking

Spirometry has been cited as a simple feedback device to encourage smoking cessation and continued abstinence.[11-13] However, use of feedback about performance on spirometry and other respiratory tests has produced mixed results, with detection of spirometric abnormalities being associated with higher smoking cessation rates in some settings,[14-16] but not in others.[17, 18] The effect of providing personal spirometry results in a health care setting in combination with access to skills training has not been adequately tested.

Exhaled carbon monoxide (CO) measurements have been used to categorize people as smokers or nonsmokers and to provide feedback to smokers who want to quit, but their value as a tool to motivate cessation remains unproven.[19-21] Because most people recognize CO as a lethal gas, elevated measures may offer an incentive to smokers whose spirometry results are still within normal range. The potential impact of using CO as a motivator is illustrated by another study in a group of adult patients in England in which exhaled CO measurements combined with general practitioners' advice to quit resulted in a 17% one-year cessation rate compared with an 11% rate in a control group.[22]

Many smoking cessation trials that test alternative intervention strategies solicit, as subjects, volunteers who are interested in quitting. Fewer have tested the effects of messages delivered to populations of smokers who have no interest or initial intention to attempt to quit, as is necessary if the impact of a motivational strategy is to be tested. The purpose of this prospective

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randomized trial was to test whether the addition of a motivational intervention would enhance smoking cessation rates compared with the provision of a standardized education approach alone in a group of outpatient smokers who were not selected for their initial motivation to quit.

## METHODS

This smoking intervention study was part of a larger, five-year Veterans Administration Demonstration Project among 1,224 outpatients that tested four preventive care delivery models.[23] One delivery model involved a randomly selected group of outpatients who were mailed annual invitations to voluntarily attend a nurse practitioner-staffed health promotion clinic. Seventy-one percent of eligible participants responded to these invitations, signed by physicians, which emphasized the opportunity to receive a personalized health check-up that included "cancer and blood pressure checks, immunizations, and health advice." Some of these responders were the subjects of this study. The availability of smoking cessation assistance was not mentioned, so that these patients, although volunteers for a health promotion clinic, were not self-selected for intent to quit smoking.

*Baseline Year.* In the baseline year prior to the randomized smoking cessation trial, 34% of clinic participants (80/238) were smokers. Nurses gave each smoker a standard, brief, and direct "You should quit" message even though almost half of the smokers indicated no interest in educational materials about smoking or in help with quitting. Forty-one smokers who wanted information were given pamphlets about the benefits of stopping and a list of community smoking cessation resources. At the return visit one year later, only two smokers (2.5%) were abstinent.

*Study Year.* The smoking cessation trial was conducted during the screening program's second year. Subjects were veterans who returned for a second annual visit as well as those who responded to invitations for the first time. Thirty-five percent of these veterans (99/285) were current smokers. Nine smokers were excluded from the study because of incomplete smoking status history or nonparticipation in the complete general preventive intervention prior to randomization to the smoking intervention. The remaining 90 smokers were randomized to a control group, which received a standard education and skills training intervention, or to a treatment group, which received the entire control intervention plus the personalized motivational intervention (Fig. 1).

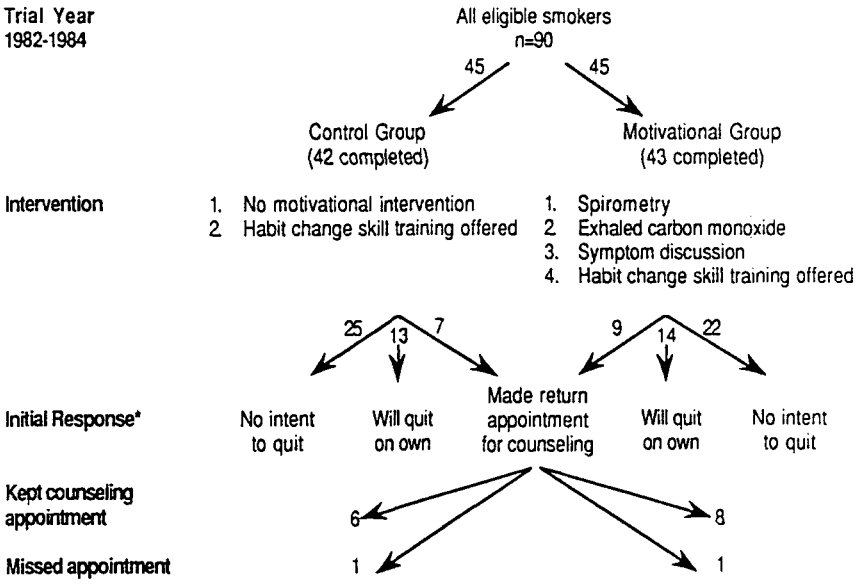


**FIGURE 1.** Design of study of effects of interventions on smoking cessation. *Smokers choosing community group or hypnosis grouped with "Will quit on own." † Telephone or letter contact made by research assistant to obtain self-reported smoking status.

| Smoking Status Contacts | Follow-up Contacts: Control Group (n = 45) | Follow-up Contacts: Motivational Group (n = 45) |
|---|---|---|
| At one month† | 39 | 34 |
| At four months† | 40 | 33 |
| At 12 months | | |
| CO-validated smoking status | 30 | 27 |
| Self-reported smoking status | 9 | 5 |
| Died | 3 | 4 |
| Unable to contact | 3 | 9 |

### The Smoking Intervention

#### *GROUP 1: CONTROL/EDUCATION*

During the trial year, the control subjects were offered a standardized, state-of-the-art, 50-minute educational intervention that described smoking risks and the health benefits of quitting (Appendix). Verbal messages and graphic charts that had been developed and tested previously with outpatient veterans were used.

Subjects were advised to stop smoking and the contents of a self-help manual were reviewed.[24] At the end of the hour-long session, the smokers were asked if they thought they would be able to quit if they made a serious attempt to do so. Smokers were encouraged to commit to a quit date and a method before leaving. Patients were also encouraged to return with family members to a free, nine-session (four-month-long), one-to-one skills training and counseling program based on the self-help materials. Those smokers who intended to quit on their own were encouraged to use the structured self-help program.[24] Nicotine polacrilex gum was not available during the study period.

#### *GROUP 2: TREATMENT/EDUCATION PLUS MOTIVATION*

The treatment group received all the interventions that the control group received, plus an additional ten-minute motivational intervention (Fig. 1). The personalized motivational intervention included: 1) spirometry with comparison of forced expiratory volume in one second and forced expiratory flow rate during the last 75–85% of exhalation to predicted normal values,[25,26] 2) measurement of the exhaled CO level, which was then compared with the expected value for a nonsmoker,[20] and 3) discussion of the smoker's pulmonary symptoms such as cough, wheeze, or dyspnea.

A dry diaphragm spirometer (Breon Corporation, New York) was used to obtain spirometric measurements. The best of three efforts was used for measurement. The results were given to the patient with information on how smoking cessation could stabilize lung function.[27] A nurse practitioner measured CO levels with the Ecolyzer (Energetics Science Inc., New York), a portable instrument that tests the rate of conversion of CO to carbon dioxide as it passes over a catalytically active electrode. A ten-item symptom questionnaire was used to identify current pulmonary symptoms.[28]

#### *FOLLOW-UP PROCEDURES FOR BOTH GROUPS*

One week after the initial intervention, all smokers who did not report for counseling were mailed a follow-up support letter from the nurse practitioner, who encouraged them to maintain any decision to quit or offered future help to those not yet ready to quit (Fig. 1). All smokers who participated were followed, even if they did not complete the full hour intervention (7% of the control group and 5% of the treatment group).

### Smoking Cessation Measurements

Subsequent smoking status was obtained at one and four months by a research assistant, blinded to the patient group, who telephoned all subjects or mailed letters to those without telephones. At the one-year follow-up visit in the screening program, the smoking status indicated on the questionnaire and in the interview was validated by exhaled CO measurement. Those with exhaled CO levels greater than 10 ppm were classified as current smokers. Attempts were made at that time to make telephone or letter contact with subjects who failed to return to the clinic.

Because of missing follow-up contacts and uneven attrition between the groups (Fig. 1), smoking quit rates were calculated using two different denominators: 1) only subjects with known follow-up smoking status, and 2) subjects for whom no follow-up contact was made or who had died were categorized as persistent smokers, resulting in a more conservative intervention result.[4] Also, because more subjects in the treatment group had missing follow-up data, an analysis that classified subjects with missing smoking status as smokers weighed against the effectiveness of the motivational intervention. The groups' quit rates were compared using the chi-square statistic with Yates' correction for two-by-two tables and a $p<0.05$ significance level for a one-directional hypothesis.[29]

## RESULTS

### Subjects

The study population comprised 86 men and four women who had smoked for three to 79 years. There were no significant differences between the control and treatment groups in age, smoking history, and number of cigarettes smoked (Table 1).

This patient population had several features known to predict lower rates of smoking cessation. Most were long-time, heavy smokers who had begun to smoke at the average age of 17 years and had smoked for more than 35 years. One third had less than a high school education. Patients had an average of five active medical conditions. One fourth of the subjects were enrolled in psychiatry programs, and 21% consumed four or more drinks daily. Many smokers lacked living environments conducive to changing smoking behavior, with 33% living alone and 39% living with other smokers.

### Intention to Quit and Choice of Methods

After the standard educational input to all subjects and the motivational feedback to the treatment group, patients were asked to commit to a smoking cessation method and to a specific quit date. About half of all smokers, 51% of the treatment group and 44% of the control group, made a decision to try to stop. Most

**TABLE 1**

Comparison of Smokers in the Control Intervention and Motivational Intervention Groups

| Characteristics | Randomized Group: Control Intervention n = 45 | Randomized Group: Motivational Intervention n = 45 | Total n = 90 |
|---|---|---|---|
| Sociodemographics | | | |
| Number of males | 42 (93%) | 44 (98%) | 86 (96%) |
| Living status | | | |
| Alone | 15 (33%) | 15 (33%) | 30 (33%) |
| With non-smoker | 14 (31%) | 12 (27%) | 26 (29%) |
| With smoker | 16 (36%) | 18 (40%) | 34 (39%) |
| Frequency of alcohol use | | | |
| None | 20 (44%) | 16 (36%) | 36 (40%) |
| 1–3 drinks/day | 14 (31%) | 14 (31%) | 28 (31%) |
| ≥4 drinks/day | 8 (18%) | 11 (24%) | 19 (21%) |
| Unknown | 3 ( 7%) | 4 (9%) | 7 (8%) |
| Smoking history | | | |
| Mean number of cigarettes smoked/day | 24 ± 15 SD | 23 ± 17 SD | 23.5 ± 15.9 SD |
| Mean pack/year history | 58.1 ± 28.4 SD | 62.8 ± 35.5 SD | 60.4 ± 32.0 SD |
| Smokers' nicotine content | | | |
| >1 mg/cig | 11 (24%) | 15 (36%) | 26 (30%) |
| <1 mg/cig | 34 (76%) | 27 (64%) | 61 (70%) |
| Number of previous quit attempts | | | |
| None | 12 (27%) | 10 (22%) | 22 (24%) |
| 1–2 | 23 (51%) | 27 (60%) | 50 (56%) |
| ≥3 | 10 (22%) | 8 (18%) | 18 (20%) |
| Initial cessation intent | | | |
| Number who stated intent to quit after session | 20 (44%) | 23 (51%) | 43 (48%) |
| Number with intent to quit who chose various methods* | | | |
| Self-help | 13 | 14 | 27 |
| 1 : 1 counseling | 7 | 9 | 16 |
| Group of hypnosis | 3 | 2 | 5 |

*Some smokers intended to use more than one quitting method. Mean age was 51.9 years for the control intervention group, 55.5 years for the motivational intervention group, and 53.7 years for both groups combined.

smokers who intended to quit preferred self-help methods (63%), while 37% agreed to return for the one-to-one skills training counseling and 12% chose community classes or hypnosis methods. (Because some smokers intended to use several sources of help, the percentage exceeded 100%.) Fourteen smokers returned for the one-to-one skills training counseling, completing an average of four sessions each.

### Subject Attrition

For seven smokers (8%), two in the control group and five in the study group, no follow-up smoking status was obtained at any of the three follow-up times. Some subjects were reached at one month and not at four months, while others were not contacted at one month but were located later. At the one-year follow-up, 19 subjects (21%) were unavailable for further analysis. Seven had died, and six had moved without leaving a forwarding address. The remaining six subjects either refused further telephone interviews or did not respond to several letters inquiring about smoking status. Although attrition was unevenly distributed in the two groups, with twice as many in the treatment ($n = 13$) as in the control group ($n = 6$), the reasons for attrition were distributed similarly in each group.

### Biochemical Validation

At one-year follow-up, 63% of patients who entered the study had their smoking status validated by exhaled CO measurement (Fig. 1). Validation information was unavailable for those smokers who did not report for their third annual visit to the health promotion clinic for reasons such as a move out of state, nursing home placement, or their decision to stop participating in the annual screening program. Only two subjects' self-reports of smoking status were contradictory to CO measurements. One patient's use of marijuana constituted smoking, while another's reported cessation conflicted with CO results.

### Self-Reported Smoking Cessation Rates

Forty percent of the smokers who were given the motivational intervention and who were contacted at least once in the subsequent 12 months reported hav-

**TABLE 2**

Self-report of Smoking Cessation by Two Study Groups over 12 Months Based on Initial Quitting Intention

| | Self-reported Quitters (No. Quit/No. Responding) | | | |
|---|---|---|---|---|
| | Contacted at 1 Month | Contacted at 4 Months | Contacted at 12 Months | Ever Quit* |
| Control group ($n = 45$) | | | | |
| No initial intent to quit ($n = 25$) | 1/20 | 3/24 | 3/21 | 3/24 |
| Intended to quit ($n = 20$) | | | | |
| Returned for counseling ($n = 6$) | 1/5 | 1/5 | 0/5 | 1/5 |
| Self-help ($n = 14$) | 0/14 | 1/11 | 2/13 | 3/14 |
| TOTAL | 2/39 | 5/40 | 5/39 | 7/43 |
| Quit rate | 5.1% | 12.5% | 12.8% | 16.3%† |
| Motivational intervention group ($n = 45$) | | | | |
| No initial intent to quit ($n = 22$) | 1/14 | 3/14 | 6/16 | 7/18 |
| Intended to quit ($n = 23$) | | | | |
| Returned for counseling ($n = 8$) | 1/7 | 3/7 | 1/6 | 3/8 |
| Self-help ($n = 15$) | 3/13 | 4/12 | 4/10 | 6/14 |
| TOTAL | 5/34 | 10/33 | 11/32 | 16/40 |
| Quit rate | 14.7% | 30.3% | 34.4% | 40.0† |

*"*Ever-quit*" category defined as self-reported cessation on at least one follow-up contact (one, four, or 12 months).
†Chi-square 4.70, $p = 0.015$.

ing quit smoking on at least one follow-up, compared with 16.3% of those in the control group (Table 2). With a chi-square comparison, significant differences between groups were found in the "ever quit" rates using either means of handling missing data ($p = 0.015$ using subjects with complete data only; $p = 0.026$ when counting missing subjects as smokers). The majority of smokers who reported quitting at each of the follow-up times had had no initial intent to quit or had planned to quit on their own rather than return for counseling (Table 2). Quit attempts, even if not sustained, indicate motivation to quit.

While some smokers stopped within four weeks of the intervention, almost half delayed their attempts to quit smoking until later. The one-, four-, and 12-month point-prevalence smoking cessation rates in the treatment group were twice as high as those for controls, using only subjects with complete follow-up information.

### Chemically Validated Smoking Cessation Rates at 12 Months

Comparing self-reported and chemically validated smoking cessation rates at 12 months (Table 3), the treatment group quit at a significantly higher rate than the control group regardless of the method of analysis. When only those subjects with CO-validated status were included, the 12-month quit rate in the treatment group was 33.3% compared with 10% in the control group ($p = 0.034$). More conservatively, assuming subjects missing to follow-up to be smokers, the higher cessation rate in the motivational intervention group (24.4% vs. 11.1% for self-reported quitting, and 20% vs. 6.7% for CO-validated cessation) still approached statistical significance ($p = 0.08$ and $p = 0.06$, respectively).

Of the 12 smokers who had chemically validated 12-month quitting status, four reported being nonsmokers at all follow-up times, while three reported quitting at both four- and 12-month follow-up contacts, suggesting that over half of the 12-month point-prevalence quit rates were sustained eight-month cessations.

## DISCUSSION

The subjects in this trial had continued to smoke despite their ages and medical conditions, indicating a need for innovative motivation to quit and access to

**TABLE 3**

Smoking Cessation Rates of Control and Motivational Intervention Groups at 12-month Follow-up

| | Quit Rate | |
|---|---|---|
| | Patients with Known Smoking Status Only No. (%) | All Patients, Missing Patients Assumed to Be Smokers No. (%) |
| Self-reported cessation | | |
| Control group | 5/39 (12.8)* | 5/45 (11.1)† |
| Motivational intervention group | 11/32 (34.4)* | 11/45 (24.4)† |
| CO-validated cessation | | |
| Control group | 3/30 (10)‡ | 3/45 (6.7)§ |
| Motivational intervention group | 9/27 (33.3)‡ | 9/45 (20)§ |

*Chi-square = 3.52, $p = 0.03$.
†Chi-square = 1.90, $p = 0.08$.
‡Chi-square = 3.36, $p = 0.03$.
§Chi-square = 2.40, $p = 0.06$.

specific skills training. We believe that the feedback of a combination of spirometry results, exhaled CO measures, and pulmonary symptoms made the smokers recognize their immediate and personal susceptibility to the negative consequences of smoking. This perception stimulated greater efforts to stop smoking. The motivational intervention tripled the percentage of outpatient smokers who were abstinent after one year compared with results from a standard educational approach.

The quit rates are especially encouraging because these smokers were not motivated volunteers for a smoking cessation trial. A substantial number of the smokers who eventually quit had had no definite plans to quit and had not set a quit date immediately after they received the initial intervention. Even though additional counseling was offered at no cost to the patients, the majority of those who quit did so on their own or with the aid of the self-help materials. This finding is important since self-help interventions are generally easier to implement, less labor-intensive, and can serve larger target populations than counseling-based programs. If the motivational approach used in this study were combined with recently devised self-help tactics, such as weekly mailings,[30] its potential impact might be even greater.

Both control and treatment groups had higher one-year quit rates than the 3% achieved in the same population over the previous year. Unlike such interventions in other settings,[1, 6] the brief stop-smoking advice and pamphlets may not have had an impact on these chronically ill outpatients, many of whom already had smoking-related diseases and had heard previous advice to quit from their physicians.

The unique nature of our older male subjects makes generalization of the study results beyond urban VA outpatient settings difficult. In health care settings where smokers are less chronically ill or have more favorable attributes for successful smoking cessation, personalized feedback about biologic test results may have a greater impact. On the other hand, use of these measures to personalize risk in our population may have been the "final straw" that led to quitting when added to previous medical advice to quit.

Since the intervention was a combination of spirometry results, exhaled CO results, and a pulmonary symptom discussion, the relative contribution of each tactic cannot be assessed. During the one-year clinic follow-up interviews, some patients commented on the impact of the spirometry information, while others seemed particularly influenced by the exhaled CO information. Given the heterogeneous nature of smokers, a multiple-intervention approach would presumably be more successful than one method alone.

We can only speculate whether use of our methods would be of any additional benefit to smokers who have already decided to quit or who are enrolled in smoking cessation programs outside of health care settings, since our intervention was delivered to smokers who had not already made a decision to quit. In one study, volunteers whose exhaled CO was measured and discussed before a behavioral smoking cessation clinic were more likely to abstain at the end of the clinic than were those whose CO was measured only after treatment.[31]

Limitations of this study include its small size and its large and uneven attrition. All smokers in the health promotion clinic were enrolled in this study regardless of their age, functional or cognitive status, prognosis, socioeconomic situation, or attitude about stopping smoking. These subject characteristics as well as limited available contact time for repeated follow-up attempts increased the number of subjects with unknown smoking status at follow-up. Although the mortality and attrition rates may seem high, they are similar to those found in other outcome studies in those older patient population at the same medical center.[23]

Interim one- and four-month quit rates are based on self-reported smoking status. Self-reported smoking status can be quite reliable,[32] and in this study correlated well with CO values at 12 months. Any bias occurring should have been comparable in the randomized groups. Nevertheless, validated rates at 12 months warrant more emphasis than the interim quit rates. The one-year quit rates achieved in this population are better than or comparable to those reported for long-term smokers or smokers attending hospital outpatient clinics.[4, 8, 33]

Other studies have evaluated the ability of feedback about pulmonary function testing[17] or exhaled CO[21] to motivate cessation, but unlike our study, this feedback was not linked with help to change smoking habits. The failure of these studies to find an effect of feedback on cigarette smoking may suggest that personalized risk information needs to be combined with access to behavioral skills training to effectively catalyze a quitting effort.

An Australian general practitioner trial has reported the success of tactics similar to ours.[34] Patients given blood carboxyhemoglobin and spirometry feedback and scheduled for six mandatory return counseling visits achieved a 33% six-month quit rate compared with a 3% quit rate in a control group. Our trial differs from this one in that ours had 1) 12-month rather than six-month follow-up, 2) use of an education and skills counseling control group rather than a non-intervention control, 3) voluntary return for counseling rather than six mandatory clinic visits, 4) immediate feedback of noninvasive CO measures rather than blood carboxyhemoglobin measurement, and 5) use of nurse rather than physician providers.

We found that individualized discussion of spirometry, exhaled CO, and pulmonary symptoms tripled the number of outpatient smokers who were abstinent after one year compared with results from a standard educational approach. The impact of these motivational tactics should be enhanced with recently devised aids, such as nicotine gum[35, 36] and tested maintenance

strategies.[37] This intervention is feasible in most outpatient clinic settings and deserves additional testing.

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### APPENDIX

One-hour Smoking Counseling Interview: Time Flow Sequence

| | |
|---|---|
| Smoking history | 5–7 minutes |
| Education<br>Smoking risks<br>Health benefits of quitting | 5–8 minutes |
| Personalized motivation tests and discussion<br>Exhaled carbon monoxide measurement<br>Spirometry<br>Symptom questionnaire | (*study group only*)<br><br><br>8–12 minutes |
| Education<br>Methods of quitting<br>Self-help approaches<br>Individualized discussion of behavioral change strategies<br>Information about low-cost community group programs | 25–35 minutes |
| Recommend return for nine-session, 4-month one-to-one counseling program | |
| Solicit intent to quit | |
| Urge selection of quit date and method | |
| Make appointment for return in one week to begin one-to-one counseling | 5 minutes |