ORIGINAL ARTICLES

Veracity of Smokers' Response Regarding Abstinence at Smoking Cessation Clinics

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OBJECTIVE: To assess the reliability of smokers' response as criteria for measuring abstinence and the necessity or not of confirming abstinence with carbon monoxide (CO) measurement.

PATIENTS AND METHODS: A multicenter, prospective, longitudinal study was carried out on patients over 18 years of age from 5 smoking cessation clinics who underwent treatment with nicotine or bupropion. When the patient attended the clinic at 15, 30, 60, 90, and 180 days, abstinence was checked by self-reporting and expired-air CO levels. Sensitivity, specificity, and positive, negative, and overall predictive value of patient reporting, measured CO levels, and the 2 procedures in combination were calculated.

RESULTS: A total of 904 smokers (476 men and 428 women) with a mean (SD) age of 42.51 (10.09) years were enrolled in the study. Of the 904 patients that made up the study population, 820, 776, 687, 719, and 679, respectively, attended the scheduled visits to check abstinence. Self-reported point-prevalence abstinence at 15 days was 74.5% and at 180 days was 57.6% while abstinence determined by expired-air CO was 75.7% and 59.4% respectively. Results according to self-reporting, CO measurement, and the 2 methods in combination were not significantly different (*P*<.05) at any of the points in time. Neither sensitivity nor specificity showed significant differences in relation to patient variables.

CONCLUSION: The reliability of self-reported abstinence from smoking is high. Measurement of CO is therefore not essential, although it could be advisable for motivating patients rather than as a way of confirming abstinence.

Key words: *Tobacco. Smoking cessation. Self-report. Carbon monoxide.*

Veracidad de la respuesta de los fumadores sobre su abstinencia en las consultas de deshabituación tabáquica

OBJETIVO: Valorar la fiabilidad de la respuesta del fumador como criterio de medida de abstinencia y el carácter de prescindible o indispensable de la determinación de monóxido de carbono (CO) para corroborar dicho criterio.

PACIENTES Y MÉTODOS: Se ha realizado un estudio multicéntrico, prospectivo y longitudinal en pacientes mayores de 18 años que acudieron a 5 consultas de tabaquismo y a quienes se pautó tratamiento sustitutivo con nicotina o bupropión. Se efectuaron controles a los 15, 30, 60, 90 y 180 días. En cada control se determinó la abstinencia mediante la respuesta dada por el paciente, la determinación de CO en aire espirado y ambos procedimientos conjuntamente. Se calcularon la sensibilidad, especificidad, valor predictivo positivo, negativo y global de la respuesta dada por el paciente respecto de la determinación de CO.

RESULTADOS: Se incluyó en el estudio a 904 fumadores (476 varones y 428 mujeres), con una edad media (± desviación estándar) de 42,51 ± 10,09 años. De los 904 acudieron a los controles programados 820, 776, 687, 719 y 679, respectivamente, que constituyen la población objeto de estudio. La abstinencia puntual a los 15 y 180 días determinada por la respuesta de los pacientes fue del 74,5 y del 57,6%, y mediante determinación de CO en aire espirado del 75,7 y del 59,4%, respectivamente. No se observaron diferencias significativas (p < 0,05) entre los 3 procedimientos a los 15, 30, 60, 90 y 180 días. Ni la sensibilidad ni la especificidad mostraron diferencias estadísticamente significativas entre las distintas categorías de las variables.

CONCLUSIÓN: La fiabilidad de la respuesta dada por los pacientes sobre la abstinencia tabáquica es elevada. Por ello la determinación de CO es prescindible y no resulta indispensable, si bien en el seguimiento del proceso puede ser recomendable como factor motivador para el paciente más que como una forma de comprobar la abstinencia.

Palabras clave: *Tabaco. Deshabituación. Autorrespuesta. Monóxido de carbono.*

Introduction

The reliability of information on smoking habits obtained from diverse population groups has been debated for many years but universally accepted

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conclusions have not yet been reached. The information is normally gathered by self-report questionnaires and through biological markers. Several authors have indicated the need to verify the sensitivity and specificity of both procedures, with contradictory results.[1-3]

The veracity of smokers' responses at smoking cessation clinics has been more questioned than any other part of the diagnostic and follow-up process of patients of this kind.[2] There are generally no doubts about the truth of smokers' responses at the initial visit when diagnosis is made and appropriate treatment and monitoring of the cessation process are offered. The same cannot be said about responses given at the follow-up sessions, which a large number of smokers do not attend and at which another percentage hide the fact that they have smoked.

Biological markers have been recommended as a means of verifying patient responses. The measurement of carbon monoxide (CO) in expired air or other markers of longer duration such as thiocyanate or cotinine have been recommended to this end. All available analytic methods have advantages and disadvantages. Traces of thiocyanate or cotinine in biological fluids such as saliva or urine indicate whether an individual has smoked during the days prior to the visit (up to 15 days before) but the cost and complexity of the technique limit clinical use.[3] Other simpler and cheaper procedures, such as measurement of CO in expired air,[4,5] are used much more but are limited by the shortness of the period in which high concentrations of CO can be observed following smoking (between 3 and 6 hours).[6] Studies aimed at validating self-report questionnaires thus recommend using a combination of both markers.[7]

There are three reasons for the usefulness of measuring CO in expired air at smoking cessation clinics: smoking intensity can be assessed (greater intensity, greater concentration); abstinence can be verified, and, lastly, abstinent smokers can observe an objective measurement of the immediate benefits of smoking cessation in the rapid decrease of CO concentration, which serves as a motivating factor. CO measurement has become the most commonly employed marker due to its reliability, simplicity, and low cost, and clinical guidelines for the diagnosis and treatment of smoking addiction usually recommend its use.[8,9] However, although CO-oximeters are normally available at specialized smoking cessation clinics, they are not always available at primary and specialized health care clinics that could and should diagnose and treat smoking addiction given the large number of smokers among their patients and the potentially high impact on public health.

The objective of our study was to assess the reliability of patient self reporting and the necessity or otherwise of confirming smoking abstinence with CO measurement given that there are occasions where CO cannot be measured. We therefore took the measurement of CO as the reference test and compared results with smokers' self report.

Patients and Methods

This prospective, longitudinal study forms part of a multicenter research project carried out according to the guidelines for the diagnosis and treatment of smoking addiction of the Spanish Society of Pulmonology and Thoracic Surgery (SEPAR).[8]

Enrollment and Exclusion Criteria

The study target population consisted of patients over 18 years of age that attended any of 5 participating smoking cessation clinics between January 1 and June 30, 2002. Suspected risk factors or contraindications for pharmacological treatment excluded patients from the study.

Intervention

Personal information (name, age, sex, address, and telephone number), clinical history, and concomitant treatment data were obtained from each patient along with information on smoking: number of cigarettes smoked per day, pack years, current stage of quitting, number of prior attempts, degree of dependence (measured by the Fagerström test), motivation (measured by the Richmond test), and CO concentrations in expired air (measured with the Micro Smokerlyzer CO-oximeter, Bedfont Scientific Limited, Rochester, UK). All information was introduced into a specially created data base.

Patients with medium to high nicotine dependence or low dependence but previous failed attempts at quitting due to abstinence syndrome were offered behavior therapy and pharmacological support according to the SEPAR guidelines.[8]

Follow-up

After the initial visit, monitoring was carried out periodically during follow up (at 15, 30, 60, 90, and 180 days). Point-prevalence abstinence was assessed at each session. The following information was recorded if abstinence had not been maintained: number of cigarettes smoked per day, degree of dependence, CO concentrations in expired air, the current stage in the smoking cessation process, and whether or not there had been changes with respect to the initial stage prior to treatment. Information offered to the patient was reinforced to try to achieve abstinence in subsequent periods.

Abstinence was monitored in all patients at each of the scheduled sessions by patient self-report, measurement of CO in expired air, and both procedures together. Self-report abstinence was assessed by asking direct, standardized questions to all patients following the study guidelines. Measurement of CO in expired air was performed according to standardized procedure using the Micro Smokerlyzer CO-oximeter at all the participating health centers. The quantity of 10 ppm of CO was established as a certain indication of smoking[10]; that value is the one commonly accepted in Western countries, although some authors use 7 ppm[11] or 8 ppm[12] as cutoff points to distinguish smokers from nonsmokers.

In accordance with the study objective, interest lay in identifying smokers that lied or, more specifically, smokers that answered "no" when asked whether they had smoked since the previous visit.

Statistical Analysis

Diagnostic reliability of smokers' self report was assessed by comparing smokers' responses with the measurement of CO in expired air, a value greater than or equal to 10 ppm being considered positive (indicating a smoker). Percentages are expressed with 95% confidence intervals. Sensitivity, specificity, and positive, negative, and overall predictive value of the response was calculated with respect to the analytic technique used as a reference test. Results were also analyzed by sex, age group (under 35, from 35 to 55, and over 55 years), for smokers of less than 20 cigarettes per day or 20 cigarettes or more, and by comorbidities at the start of the study. The χ^2 test was used to compare results between groups. A *P* value of less than .05 was considered significant.

TABLE 1
Patient Characteristics at Start of Study*

Variables	Patients (n=904)
Sex	
Men	445 (52.6)
Women	428 (47.4)
Age, years†	42.51 (10.1)
Comorbidities	
Yes	346 (38.3)
No	558 (61.7)
Previous attempts at quitting smoking	
Yes	722 (79.9)
No	182 (20.1)
Cigarettes/day	25.20 (12.0)
Pack years†	24.10 (14.2)
CO†	24.80 (10.2)
Weight, kg†	72.78 (23.3)
Fagerström test	
<4	64 (7.08)
4-6	395 (43.69)
>6	445 (49.23)

*Data are expressed as numbers (%) unless otherwise indicated. CO indicates carbon monoxide.
†Data are expressed as means (SD).

Results

There were 904 smokers enrolled during the study period, 476 men and 428 women, with a mean (SD) age of 42.5 (10.1) years. A total of 346 presented comorbidities, 558 not presenting any condition associated with smoking. Of the 904 patients that made up the study population, the following numbers attended the monitoring sessions: 820 at 15 days, 776 at 30 days, 687 at 60 days, 719 at 90 days, and 679 at 180 days. Characteristics of the patients at the beginning of the study are presented in Table 1.

Point-prevalence abstinence of the patients who attended the scheduled monitoring sessions are presented in Table 2 and varied from 74.5% at 15 days to 57.6% at 6 months when measured by patient self report; from 75.7% at 15 days to 59.4% at 6 months when CO in expired air was found to be less than 10 ppm, and from 72.3% at 15 days to 57.4% at 6 months when both procedures were measured together. No significant differences were observed ($P<.05$) between the 3 measurements at 15, 30, 60, 90, and 180 days.

Table 3 shows how patient self reporting of abstinence showed high levels of sensitivity, specificity, and predictive values at all monitoring sessions in relation to the CO cutoff levels. Self-report reliability continued to be high when analyzed in relation to different age groups, smoking intensity, comorbidity, and sex (Table 4). Neither sensitivity nor specificity of the techniques was significantly different in relation to the different variables.

Discussion

One of the difficulties encountered in studies on smoking is how to accurately measure the prevalence of smokers. Traditionally, prevalence in population studies has been measured through questionnaires despite repeated indications of the limitations of this method and the need to validate study populations' self-reported

TABLE 2
Comparison Between Patient Self Reporting and Measurement of Carbon Monoxide (CO) in Expired Air at Each Monitoring Session*

Variable	15 Days (n=820)	*P*, Test 1	*P*, Test 2	1 Month (n=776)	*P*, Test 1	*P*, Test 2	2 Months (n=687)	*P*, Test 1	*P*, Test 2	3 Months (n=719)	*P*, Test 1	*P*, Test 2	6 Months (n=679)	*P*, Test 1	*P*, Test 2
Patient self reporting	611 74.50% (71.5-77.5)			620 79.90% (77.0-81.7)			557 81.10% (78.1-84.0)			546 75.90% (72.8-79.0)			391 57.60% (53.8-61.3)		
CO<10 ppm	621 75.70% (72.8-78.7)	0.55		607 78.20% (75.3-81.1)	0.66		569 82.20% (79.4-85.1)	0.78		556 77.30% (74.3-80.4)	0.53		403 59.30% (55.7-63.0)	0.5	
Both procedures	593 72.30% (69.2-75.4)		0.59	607 78.20% (75.3-81.1)		0.64	550 80% (77.1-83.0)		0.74	540 75.10% (71.9-78.3)		0.6	390 57.40% (53.7-61.1)		0.72

*95% confidence intervals are shown in parenthesis. Test 1 is the comparison between CO and patient self reporting; test 2 is the comparison between CO, patient self reporting, and the 2 procedures together.

TABLE 3
Reliability of Patient Self Reporting at Each Follow-up Stage

Criteria	15 Days	1 Month	2 Months	3 Months	6 Months
Sensitivity, %	95.5	100	96.7	97.1	96.8
Specificity, %	90.9	92.3	94.1	96.3	99.6
Positive predictive value, %	97.0	97.9	98.7	98.9	99.7
Negative predictive value, %	86.6	100	85.4	90.7	95.5
Overall predictive value, %	94.4	98.3	96.2	96.9	97.9

abstinence with biological markers. This situation has been pointed out by authors of both general population studies[12,13] and studies of specific population groups such as adolescents,[14,15] particularly in studies that assess the efficacy of smoking cessation treatment.[16,17]

As mentioned, one of the difficulties found in the diagnosis and treatment of tobacco dependence is finding a way of measuring the efficacy of the prescribed treatment: a considerable number of patients do not attend the monitoring sessions and it is assumed that another percentage do not tell the truth at the sessions. Consequently, efficacy results are usually analyzed on an intention-to-treat basis, and biological markers—the most common being CO in exhaled air—are recommended to confirm the veracity of patient self-reported abstinence.[18]

The assumption that patients who attend monitoring sessions do not always tell the truth with regard to abstinence stems from the fact that smokers do not consider themselves to be ill and are therefore reluctant to accept the discipline demanded in behavioral therapy or the risks involved in pharmacological treatment to quit smoking. If, then, smokers are predisposed against strictly following the treatment recommendations, there is room for doubt over whether they tell the truth when referring to their abstinence.

In order to resolve this problem, CO monitoring has been recommended as a biological marker of abstinence. However, smoking is not a continuous process and CO measurement has time-limited validity, between 3 and 8 hours, and thus is only useful to reflect the hours prior to the monitoring session. Glynn et al[19] have also shown the close relation that exists between self reporting and CO measurement when patients know that CO testing will be performed and what it implies, an essential aspect from the ethical point of view. These authors found a difference of up to 16% between self-reported results of patients who knew in advance of the use of the CO monitor with those who did not when answering whether they smoked. It must also be considered that smokers who attend the scheduled monitoring sessions during follow up of smoking cessation generally end up knowing the limitations of the technique and can therefore abstain from smoking during the hours previous to the session and avoid being identified as active smokers while continuing to smoke.

Other techniques also have limitations. Cotinine presents difficulties in the validation of abstinence when smokers follow nicotine substitution treatment and in these cases thiocyanate or anabasine are used instead—but they also have limitations, as thiocyanate can be influenced by diet. Consequently, and because of the inherent difficulties of these other more complex techniques, knowing the reliability of patient self-reported abstinence becomes especially important.

The use of CO measurement as a reference test implies the establishment of an exact concentration as a cutoff point above which a person is considered a smoker. An increase in the CO concentration cutoff point will result in higher sensitivity, and a decrease will result in the opposite. In this study we used a CO concentration cutoff point greater than or equal to 10 ppm, which is the cutoff normally accepted although some authors use concentrations of 7 ppm[11] or 8 ppm.[12] If we had used CO concentrations of greater than or

TABLE 4
Reliability Criteria (Sensitivity and Specificity) of Patient Self Reporting by Sex, Age, Smoking Intensity, and Comorbidity, Measured at Each Monitoring Session

Monitoring Session	Sex		Age, Years			Cigarettes/Day		Comorbidities	
	Men	Women	<35	35-55	>55	<20	≥20	Yes	No
15 days									
Sensitivity, %	95.4	98	97	95.4	93.6	97.1	97.1	94.7	96
Specificity, %	89	97	90	90.6	90.9	95.1	96.2	90	91.7
1 month									
Sensitivity, %	97.9	94.2	96.2	96.4	96.7	96.5	96.4	100	100
Specificity, %	90.8	95.2	92.9	93.1	78.3	68.4	94.1	88.1	95.1
2 months									
Sensitivity, %	97.7	95.2	95.7	97	94.7	94.3	97	96.9	96.5
Specificity, %	90.3	98.2	100	95.2	82.3	100	93.3	91.2	96.7
3 months									
Sensitivity, %	97.1	96.9	98	96.7	96.6	94	97.6	97.3	97
Specificity, %	95.1	97.6	93.9	87.5	100	90.9	97.3	95	97.1
6 months									
Sensitivity, %	98.7	94.4	93.6	97.2	100	96	97	98.1	95.9
Specificity, %	100	99.2	98.3	100	100	100	99.6	100	99.4

equal to 7 ppm, self-report reliability would have remained the same; for example, at the 6-month monitoring session, self-report sensitivity at this cutoff concentration would have been 98.43%, and specificity, 93.77%.

We did not find significant differences when abstinence was assessed by self report, by CO concentrations, or by both procedures together. Murray et al[20] showed that self reporting overestimated abstinence by 9.8% when compared with CO measurement. Other authors such as Velicer et al[21] found false negatives in 6% of smokers' self reported abstinence compared with assessment by CO in expired air. In our study the percentage of false negatives ranged from 2% to 3% at all monitoring sessions, but our follow up was only 6 months whereas the results of Murray et al referred to a year's follow up.

Another important aspect to be considered is the possible variation in self-report reliability during follow up of smoking cessation. In a later study Murray et al[22] found discrepancies between results using cotinine in saliva and CO in expired air and self report in a cohort of smokers who participated in a smoking cessation study with a 5-year follow up. These discrepancies persisted throughout follow up but decreased over time, possibly because the smokers' initial reluctance to openly express their attitude to smoking diminished as they came to know the doctors better. Another explanation is that the patients who continue going to monitoring sessions are those managing to quit smoking and are more motivated to tell the truth regarding smoking. We observed no significant differences at any of the monitoring sessions so patients told the truth to the same extent at the beginning of the study when their relation with the health center was more superficial as they did at the end when their relationship was closer after a large number of monitoring sessions within a short period. The consistency of patient self-report reliability was also measured for each sex, different age groups, comorbidity, and 2 degrees of intensity: moderate (less than 20 cigarettes per day) and high (greater or equal to 20 cigarettes per day).

The fact that results remain consistent when the existence of associated comorbidity is analyzed is particularly important as it could be supposed that a smoker suffering from an associated disease might lie to the doctor who was treating him and had recommended that he quit smoking.

In a cross-sectional study carried out in Finland in which serum concentrations of cotinine were used to validate smokers' responses, Vartiainen et al[23] concluded that self-report validity was high. Other authors have come to the same conclusion, both in cross-sectional studies[2] and studies examining procedures to quit smoking.[24,25] Our results coincide with theirs. Other authors have shown that self report underestimates the percentage of smokers, making the use of biological markers necessary.[12]

Thus, the results found by several authors indicate that expired CO measurement can detect a percentage, always below 10%, of false negatives in self-reported smoking particularly when patients have been informed that CO measurement will be performed. In our study we found between 2% and 3% of false negatives.

We believe that these results demonstrate the high level of reliability of self-reported abstinence in smokers who attend smoking cessation clinics and that the use of CO measurement in follow up is beneficial, when available, particularly as a motivating factor for patients rather than proof of abstinence. However, the conclusion that CO measurement can be dispensed with in smoking cessation treatment supports the recommendation that all medical caregivers should provide smoking cessation treatment whether or not CO measurement can be performed.

REFERENCES

1. Petitti DB, Friedman GD, Kahn W. Accuracy of information on smoking habits provided on self-administered research questionnaires. Am J Public Health. 1981;71:308-11.
2. Pershagen G. Validity of questionnaire on smoking and other exposures, with especial reference to environmental tobacco smoke. Eur J Respir Dis. 1984;133 Suppl:76-80.
3. Waage H, Silsand T, Urdal P, Langard S. Discrimination of smoking status by thiocyanate and cotinine in serum, and carbon monoxide in expired air. Int J Epidemiol. 1992;21:488-93.
4. Jarvis MJ, Russell MAH, Salojee Y. Expired air carbon monoxide: a simple breath test of tobacco smoke intake. BMJ. 1980;281:484-5.
5. Irving JM, Clark EC, Crombie IK. Evaluation of a portable measure of expired-air carbon monoxide. Prev Med. 1988;17:109-15.
6. Deller A, Stenz R, Forstner K, Konrad F. The elimination of carboxyhemoglobin–gender specific and circadian effects. Infusionsther Transfusionsmed. 1992;19:121-6.
7. Patrick DL, Cheadle A, Thompson DC, Diehr P, Koepsell T, Kinne S. The validity of self-reported smoking: a review and metaanalysis. Am J Public Health. 1994;84:1086-93.
8. Jiménez Ruiz CA, Solano Reina S, González de Vega JM, Ruiz Pardo MJ, Flórez Perona S, Ramos Pinedo A, et al. Normativa para el tratamiento del tabaquismo. Arch Bronconeumol. 1999;35: 499-506.
9. Jiménez Ruiz CA, Barrueco Ferrero M, Solano Reina S, Torrecilla García M, Domínguez Grandal F, Díaz-Maroto Muñoz JL, et al. Recomendaciones en el abordaje diagnóstico y terapéutico del tabaquismo. Documento de consenso. Arch Bronconeumol. 2003; 39:35-41.
10. Jarvis MJ, Tunstall-Pedoe H, Feyerabend C, Vesey C, Saloojee Y. Comparison of tests used to distinguish smokers from non-smokers. Am J Public Health. 1987;77:1435-8.
11. Nakayama T, Yamamoto A, Ichimura T, Yoshiike N, Yokoyama T, Fujimoto EK, et al. An optimal cutoff point of expired-air carbon monoxide levels for detecting current smoking: in the case of a Japanese population whose smoking prevalence was sixty percent. J Epidemiol. 1988;8:140-5.
12. Coultas DB, Howard CA, Peake GT, Skipper BJ, Samet JM. Discrepancies between self-reported and validated cigarette smoking in a community survey of New Mexico Hispanics. Am Rev Respir Dis. 1988;137:810-4.
13. Morabia A, Bernstein MS, Curtin F, Berode M. Validation of self-reported smoking status by simultaneous measurement of carbon monoxide and salivary thiocyanate. Prev Med. 2001;32:82-8.
14. Dolcini MM, Adler NE, Lee P, Bauman KE. An assessment of the validity of adolescent self-reported smoking using three biological indicators. Nicotine Tob Res. 2003;5:473-83.
15. Barrueco M, Cordovilla R, Hernández-Mezquita MA, González JM, de Castro J, Rivas P, et al. Veracidad en las respuestas de niños, adolescentes y jóvenes a las encuestas sobre el consumo de tabaco realizadas en los centros escolares. Med Clin (Barc). 1999;112:251-4.

16. Barrueco M, Torrecilla M, Maderuelo JA, Jiménez Ruiz C, Hernández M, Plaza MD. Valor predictivo de la abstinencia tabáquica a los dos meses de tratamiento. Med Clin (Barc). 2001; 116:246-50.
17. Gariti P, Alterman AI, Ehrman R, Mulvaney FD, O'Brien CP. Detecting smoking following smoking cessation treatment. Drug Alcohol Depend. 2002;65:191-6.
18. Prignot J. Quantification and chemical markers of tobacco-exposure. Eur J Respir Dis. 1987;70:1-7.
19. Glynn SM, Gruder CL, Jegerski JA. Effects of biochemical validation of self-reported cigarette smoking on treatment success and on misreporting abstinence. Health Psychol. 1986;5:125-36.
20. Murray RP, Connett JE, Lauger GG, Voelker HT. Error in smoking measures: effects of intervention on relations of cotinine and carbon monoxide to self-reported smoking. The Lung Health Study Research Group. Am J Public Health. 1993;83:1251-7.
21. Velicer WE, Prochaska JO, Rossi JS, Snow MG. Assessing outcome in smoking cessation studies. Psychol Bul. 1992;11:23-41.
22. Murray RP, Connet JE, Istvan JA, Nides MA, Rempel-Rossum S. Relations of cotinine and carbon monoxide to self-reported smoking in a cohort of smokers and ex-smokers followed over 5 years. Nicotine Tob Res. 2002;4:287-94.
23. Vartiainen E, Séppala T, Lillsunde P, Puska P. Validation of self reported smoking by serum cotinine measurement in a community-based study. J Epidemiol Community Health. 2002; 56:167-70.
24. Wood-Baker R. Outcome of a smoking cessation programme run in a routine hospital setting. Inter J Med. 2002;32:24-8.
25. Becoña E, Vázquez FL. Self-reported smoking and measurement of expired air carbon monoxide in a clinical treatment. Psychol Rep. 1998;83:316-8.