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The Validity of Self-reported Recent Smoking in Head and Neck Cancer Surgical Patients

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Author Contributions

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Abstract

Objective—In cancer patients, cigarette smoking causes poorer response to treatment, treatment toxicity, increased risk of recurrence, higher surgical complication rates, and poorer overall survival. As such a significant determinant of patient prognosis, accurate classification of current smoking status is important. Self-reported smoking status may lead to misclassification if patients conceal their true status. The purpose of this study was to assess the validity of self-reported tobacco use during the previous 48 hours in head and neck cancer patients on the day of surgery.

Study Design—Cross-sectional.

Setting—Two academic medical centers in the southeastern United States.

Subjects and Methods—On the day of surgery, 108 head and neck cancer patients completed a survey asking about tobacco use during the past 48 hours and had semi-quantitative levels of urinary cotinine measured to biochemically validate self-reported recent smoking.

Results—Self-reported smoking yielded a sensitivity of 60.9% (95% CI, 45.4%-74.9%) and a specificity of 98.4% (95% CI, 91.3%-100.0%). The sensitivity increased to 76.1% (95% CI, 61.2%-87.4%) when allowing for the possibility that exposure to secondhand smoke or use of nicotine-containing products could have caused a positive cotinine test.

Conclusion—In this patient population, self-reported recent smoking yielded a high (39%) proportion of false-negatives, and even 24% remained false-negatives after allowing for other sources of nicotine exposure. This magnitude of underreporting combined with the importance of tobacco use to patient prognosis supports the need for routinely biochemically verifying recent tobacco use in self-reported nonsmokers within the clinical setting.

Keywords

cigarette smoking; cotinine; measurement of smoking status; validity; research methods; cancer patients

Introduction

For the first time, the 2014 Surgeon General's Report reached the conclusion that cigarette smoking in cancer patients is a cause of adverse outcomes such as treatment toxicities, increased risk of recurrence, and death.¹ These important adverse consequences of continued cigarette smoking in cancer patients make it clinically imperative to accurately determine whether or not a patient is a current cigarette smoker.

The most straightforward and informative way to assess smoking status is via patients' self-report using well-defined tobacco use questions. However, the validity of self-reported smoking in cancer patients has been questioned on the grounds that smokers tend to conceal it. The extent to which cancer patients falsely report their smoking can be measured by comparing biochemical measures of smoking to self-reported smoking status. A small but growing literature on the accuracy of self-reported smoking in populations of cancer patients indicates that the accuracy of self-reported smoking status, particularly among self-reported nonsmokers, may be suspect.²⁻⁸ For example, in prior studies of cancer patients, the rate of smokers reporting that they were not smokers (ie, false-negative rate) has ranged from 20% to 50%.²⁻⁶ This prior evidence indicates there is value in evaluating ways to improve the measurement of smoking in the clinical setting. However, the evidence for the routine use of biomarkers of tobacco use within the clinical setting is currently insufficient to make evidence-based recommendations. Given the existing uncertainty around these issues, the present study was carried out to assess the validity of self-reported recent tobacco use in a population of head and neck cancer patients presenting for surgical intervention.

Methods

Study Population

This study was conducted at 2 academic medical centers, the Medical University of South Carolina and Wake Forest University, with Institutional Review Board approval at both sites. To be eligible, patients had to be ≥ 18 years of age, diagnosed with a new or recurrent stage I-IV squamous cell carcinoma of the upper aerodigestive tract, and scheduled to undergo a major surgical procedure (ie, tumor resection with or without neck dissection and/or reconstruction). A total of 108 patients who completed study activities were recruited from head and neck cancer clinics from June 2011 through October 2012. All potential participants were informed that they would be asked to complete 2 data collection activities the day of surgery, including (1) a brief 5-minute survey to ask about their recent use of tobacco and nicotine replacement therapy and (2) providing a urine specimen to test for cotinine. Participants were told that cotinine is a byproduct of tobacco. Patients were informed that the purpose of the urine sample collection was to obtain an objective measure of tobacco use and exposure. The transparency in the protocol concerning informing patients about the procedures used to validate self-reported smoking with a biochemical test should translate well to cotinine testing in the clinical setting as it facilitates the subsequent clinician-patient discussions for patients who self-report no current tobacco usage but who test positive for cotinine at levels consistent with current active tobacco use.

Participants completed a baseline questionnaire before surgery as part of a larger longitudinal study⁹ that assessed smoking history and a variety of demographic, clinical, psychological, and behavioral factors. The data for this report largely rely on information collected when, prior to entering the operating room, the patients completed a brief survey assessing their self-reported tobacco use in the prior 48 hours. Items were used to assess (1) use of combustible tobacco products (cigarettes, cigars, pipes) or smokeless tobacco products (chewing tobacco, snuff, snus); (2) use of nicotine replacement therapies (NRT) (patch, gum, or inhaler); (3) exposure to secondhand smoke (SHS) in the home, workplace,

or car; and (4) notes taken to document the use of electronic cigarettes (e-cigarettes). A urine sample was collected pre- or intraoperatively to measure urinary cotinine concentration.

Biochemical Measurement of Recent Tobacco Use: Urinary Cotinine Measurement

Urinary cotinine concentrations were used as the biomarker of tobacco use against which self-reported tobacco use was compared. Cotinine is a principal metabolite of nicotine. Cotinine has a half-life of approximately 20 hours¹⁰ but is detectable for longer time windows due to its low rate of excretion. Thus, assessment of tobacco/nicotine use was specifically limited to self-reported use within the preceding 48 hours. Cotinine is specific to nicotine exposure but does not distinguish between routes of administration either via tobacco (smoked, chewed, SHS) or via NRTs or vaporized nicotine delivery devices. SHS exposure can result in cotinine concentrations similar to those seen in low frequency smokers.^{11,12} To account for this, the study patients were asked about tobacco use, SHS exposure, and NRT use. Secondhand exposure to the vapor from e-cigarettes results in cotinine concentrations similar to secondhand tobacco smoke exposure,¹³ but this was not accounted for in the present study, except when offered by the patient. For purposes of the present study, SHS exposure is relevant to the extent it could result in cotinine concentrations consistent with active tobacco use in a patient who is not a current tobacco user but not for purposes of distinguishing between non-current tobacco users who were and were not exposed to SHS.

The patients' urinary cotinine concentration was immediately tested after the sample was retrieved using NicAlert (Nymox Pharmaceutical Corporation, Hasbrouck Heights, New Jersey, USA). Urine sample collection was used to overcome potential challenges in the collection of saliva in head and neck cancer patients with xerostomia.¹⁴ NicAlert provides a test strip that is dipped into the urine, whereby a colorimetric immunoassay test generates a semi-quantitative (ie, ordinal) measure of cotinine concentration with values ranging from 0 (0-10 ng/mL) to 6 (> 1000 ng/mL). The cutoff point for distinguishing a positive from a negative test for tobacco use in the past 48 hours was ≥ 3 (> 100 ng/mL) as per manufacturer's instructions. The results of validation studies that compared NicAlert using a cutoff value of ≥ 3 compared to GC/MS or LC-MS/MS assays that used a cutoff of 50 or 100 ng/mL have usually yielded estimates of sensitivity and specificity $\geq 90\%$.¹⁵⁻¹⁸

Statistical Analysis

Descriptive statistics were used to characterize the study population. The validity of self-reported smoking status was assessed using the urinary cotinine values as the "gold standard" to assess the sensitivity, specificity, and positive and negative predictive value of self-reported smoking. Exact 95% confidence intervals around these proportions were calculated.

Results

Participants were an average age of 59 years and predominantly male (74%) and non-Hispanic whites (81%). The most common primary tumor sites were oral cavity (39%), hypopharynx/larynx (29%), and oropharynx (24%). Forty-one percent of participants

presented with recurrent or persistent disease; the majority (53%) of the patients were diagnosed with stage IV disease, with 19%, 8%, and 20% diagnosed with stage I, II, and III disease, respectively.

Validity was assessed by comparing self-reported use of combustible or smokeless tobacco products during the past 48 hours to the results of the urinary cotinine test, which was taken to be the gold standard. Among the 46 patients who were classified as positive for tobacco exposure based on urinary cotinine concentrations, 28 self-reported recent tobacco use (true-positives), and 18 reported no tobacco use in the past 48 hours (false-negatives), yielding a sensitivity for self-reported smoking of 60.9% (95% CI, 45.4%-74.9%) (**Table 1, part A**). Among the 62 patients who were classified as negative for tobacco exposure based on urinary cotinine concentrations, 61 reported no recent tobacco use (true-negatives), and 1 reported tobacco use (false-positive), yielding a specificity for self-reported smoking of 98.4% (95% CI, 91.3%-100.0%). Predictive values are a function of the prevalence of the outcome in the study population, but at least under the circumstances of this study, the high specificity translated into a high positive predictive value for self-reported tobacco use (96.6%; 95% CI, 82.2%-99.9%), whereas the low sensitivity resulted in a relatively low negative predictive value for self-reported non-use of tobacco (77.2%; 95% CI, 66.4%-85.9%). The prevalence of patients with recurrent disease in the study population was substantial; we hypothesized patients with recurrent disease would have a greater degree of underreporting of smoking than those with a first-time diagnosis. The data did not strongly support this hypothesis, however, as the sensitivity and specificity among patients with recurrent disease were 56.3% and 96.4%, respectively, and thus differed only slightly compared with 63.3% and 100% among those with a first-time diagnosis.

Reasons other than false reporting of recent tobacco use could have contributed to a false-negative classification. A patient who honestly reported non-use of tobacco during the previous 48 hours could still have tested positive on the cotinine test because of exposure to nicotine via exposure to SHS or use of NRT or e-cigarettes. We thus reassessed the data using as the outcome self-reported nicotine exposure to include other sources of nicotine (including NRT, e-cigarettes, and SHS exposure). Among those who reported no tobacco use ($N = 79$), 13 reported SHS exposure, 1 reported NRT use, and 1 reported e-cigarette use; of these 15 individuals exposed to nicotine, 7 had a positive cotinine test. Classifying these 15 individuals who reported no tobacco use but did report exposure to SHS or other sources of nicotine use as positive for nicotine exposure (**Table 1, part B**), the sensitivity increased from 60.9% to 76.1% (95% CI, 61.2%-87.4%), and the specificity dropped from 98.4% to 85.5% (95% CI, 74.2%-93.1%). This resulted in a lower positive predictive value (79.6%; 95% CI, 67.6%-91.5%) and higher negative predictive value (82.8%; 95% CI, 71.3%-91.1%) for nicotine exposure compared to active tobacco use.

Discussion

The validity of the measurement of tobacco use in head and neck cancer patients is an important issue due to the numerous serious adverse health consequences of continuing to smoke after diagnosis.¹ In the present study, 39% of head and neck cancer surgical patients tested biomarker-positive even though they denied use during the past 48 hours. Even after

using nicotine exposure as the outcome to allow for the fact that SHS exposure and NRT and e-cigarette use can lead to a positive cotinine test, 24% of patients were still classified as false-negatives. Such major errors in the classification of patient smoking status could have important implications for response to treatment, clinical course of the disease, and ultimately survival.¹ Further, misreporting of smoking status could decrease opportunities for referral of patients who currently smoke to cessation support services.¹⁹

Studies have been conducted of surgical outcomes in head and neck cancer surgical patients that compared smoking status measured by self-report versus biochemically measured current smoking status. The cotinine biomarker was observed to yield a much stronger association than self-reported smoking status with wound complications following surgery in 1 study,²⁰ but in another similarly designed study, self-reported smoking status was observed to be a stronger predictor of poor outcomes than the cotinine biomarker because former smokers tended to have poorer outcomes than never smokers.⁹ These previous studies highlight the importance of correctly classifying current smoking status, with an emphasis on the fact that a patient's past smoking history also provides important clinical information that is complementary to biochemical measurements.

The results of the present study are closely aligned with prior published reports from similarly designed studies in cancer patients, suggesting the relatively common occurrence of false-negative reports of recent tobacco use in the present study seems to reflect the usual degree of reporting error in self-reported smoking seen in patients in the clinical setting. In studies that used serum cotinine as the biomarker of tobacco exposure, estimates of sensitivity have ranged from 50% to 80%,²⁻⁶ and estimates of specificity have been 93%^{2,3,5,6} except in 1 study where specificity equaled 80%.⁴ Four of these 5 studies were in head and neck cancer patients,²⁻⁵ and the remaining study was in newly diagnosed breast, lung, and prostate cancer patients.⁶ In 2 studies of head and neck cancer patients, when salivary cotinine was used as the biomarker of tobacco use values of sensitivity of 90%⁷ and 94%⁸ were observed. These values of sensitivity were markedly higher than in our study of urinary cotinine or the studies based on serum cotinine noted previously while still retaining similarly high values for specificity. The reasons for the discrepancy in the results between the studies that measured saliva cotinine compared to urine or serum cotinine are uncertain, but holding other factors constant, the fact that the sensitivity of self-reported smoking appears to be more accurate when saliva cotinine is used as the gold standard suggests that saliva cotinine is likely a less optimal gold standard than urine or serum cotinine. Thus, when the evidence base on the accuracy of self-reported tobacco use among head and neck cancer patients based on the results of serum and urine-based cotinine studies is considered in total, the present study adds to a growing body of evidence²⁻⁵ indicating that the accuracy of self-reported current tobacco use is suboptimal among head and neck cancer patients.

There is an extensive literature on the classification of smoking status in the general population of adults and among youths. However, from this vast literature, the present study focuses on the classification of smoking status in the oncology clinical setting with a specific focus on head and neck cancer patients. Compared with the general population, important differences seen in the head and neck cancer patient population are the high prevalence of tobacco use and the higher rates of underreporting of current tobacco use.

Given the unique characteristics of the head and neck cancer patient population compared to the general population, it is important to have studies that focus specifically on head and neck cancer patients, of which there is a small pool of studies that have provided data on this specific topic. The literature on this specific topic consists of 6 prior studies. Compared with these 6 prior studies, what makes the present study unique is the following: (1) assessment of tobacco use and biomarker collection on the day of surgery; (2) restricting self-reported current smoking to 48 hours, a time window that corresponds to nicotine clearance rate (ie, half-life of cotinine); (3) accounting for other factors such as SHS exposure and NRT use that could result in false-negative tests; and (4) real-time on-site assessment of urinary cotinine using a clinic-friendly test that gives rapid results and is easy to use in the clinical setting.

The study also had limitations. We were able to control for some factors that could contribute to discordant classification of smoking status between self-report and biochemical measures, such as SHS exposure and NRT, but other products such as vaporized nicotine delivery devices (eg, e-cigarettes) that could have interfered with correctly classifying patients' smoking status were not uniformly ascertained for either active or passive exposure. Both active and passive exposure to vaporized nicotine results in elevated cotinine concentrations.^{13,21,22} Thus, patients who self-reported no recent tobacco use but had actively or passively been exposed to the vapor from vaporized nicotine delivery devices could have erroneously been classified as false-negatives. E-cigarette use is escalating, but overall prevalence is still very low,²³ so this is unlikely to have materially impacted the results. Nonetheless, the rapidly changing marketplace for nicotine delivery products necessitates cataloging patients' active and passive exposure to a growing list of products.

Focusing on a narrow 48-hour time window that coincides with the half-life of cotinine was a study strength. However, the possibility remains that some false-negative classifications could have been due to patients whose most recent use of tobacco products was just beyond the 48-hour time window still having detectable cotinine levels. Previous studies that longitudinally measured urinary cotinine in smokers in the days after they stopped smoking have observed that urinary cotinine can sometimes remain in the elevated range for 4 days or longer.^{24,25} In the future, this issue can be more precisely addressed by asking recent tobacco users specifically about the timing of their most recent tobacco use. For example, resolution of this issue could be achieved if questions asked specifically about the previous 48, 72, and 96 hours.

All tests, even the so-called "gold standard" tests, are subject to measurement error. Thus, a portion of the observed misclassification could have been potentially contributed by the NicAlert test. The manufacturer of the NicAlert test lists on their webpage that the sensitivity and specificity of the NicAlert test at a concentration of 100 ng/ml in urine is 87% and 100%, respectively. These webpage results do not conform to the results of validation studies published in the peer-reviewed literature that compared NicAlert using a cutoff value of 3 (as in the present study) compared to GC/MS or LC-MS/MS assays that used a cutoff of 50 ng/ml or 100 ng/ml. These peer-reviewed studies have, with 1 exception, yielded estimates of sensitivity and specificity 90%.¹⁵⁻¹⁸ The exception was the study of Acosta et al,²⁴ that yielded a sensitivity of 98% but a specificity of only 58%. The results of

Acosta et al²⁴ notwithstanding, the overall excellent validity established for the NicAlert test along with the fact that any errors would be expected to be nondifferential with respect to reporting of smoking status suggest that errors introduced by the NicAlert test likely would have at most only a minor impact on the study findings.

Conclusions

The results of the present report reinforce the growing body of evidence indicating there is substantial underreporting of current smoking status in head and neck cancer patients. Similar results would be expected for other smoking-caused malignancies, but this needs further evaluation. The importance of accurately assessing smoking status on patient prognosis and the degree of underreporting of current smoking status observed in this and other studies provide support for incorporating biomarkers of tobacco use into the clinical care of head and neck cancer patients.

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References

1. U.S. Department of Health and Human Services. The Health Consequences of Smoking—50 Years of Progress. A Report of the Surgeon General. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Office on Smoking and Health; Atlanta, GA: 2014.
2. Whittet HB, Lund VJ, Brockbank M, Feyerabend C. Serum cotinine as an objective marker for smoking habit in head and neck malignancy. *J Laryngol Otol*. 1991; 105:1036–1039. [PubMed: 1787356]
3. Khuri FR, Kim ES, Lee JJ, et al. The impact of smoking status, disease stage, and index tumor site on second primary tumor incidence and tumor recurrence in the head and neck retinoid chemoprevention trial. *Cancer Epidemiol Biomarkers Prev*. 2001; 10:823–829. [PubMed: 11489748]
4. Hald J, Overgaard J, Grau C. Evaluation of objective measures of smoking status—a prospective clinical study in a group of head and neck cancer patients treated with radiotherapy. *Acta Oncol*. 2003; 42:154–159. [PubMed: 12801134]
5. Warren GW, Arnold SM, Valentino JP, et al. Accuracy of self-reported tobacco assessments in a head and neck cancer treatment population. *Radiother Oncol*. 2012; 103:45–48. [PubMed: 22119370]
6. Morales NA, Romano MA, Cummings KM, et al. Accuracy of self-reported tobacco use in newly diagnosed cancer patients. *Cancer Causes Control*. 2013; 24:1223–1230. [PubMed: 23553611]
7. Sandhu S, Humphris G, Whitley S, Cardozo A, Sandhu A. Smoking habits in patients who have been treated for an oral cancer: validation of self-report using saliva cotinine. *Oral Oncol*. 2004; 40:576–578. [PubMed: 15063384]
8. Sivasithamparan J, Visk CA, Cohen EE, King AC. Modifiable risk behaviors in patients with head and neck cancer. *Cancer*. 2013; 119:2419–2426. [PubMed: 23575663]
9. Hatcher JL, Sterba KR, Tooze JA, et al. Tobacco use and surgical outcomes in head and neck cancer patients. *Head Neck*. [published online December 18, 2014] doi:10.1002/hed.23944.
10. Hatsukami DK, Hecht SS, Hennrikus DJ, Joseph AM, Pentel PR. Biomarkers of tobacco exposure or harm: application to clinical and epidemiological studies. *Nicotine Tob Res*. 2003; 5:384–396.

11. Goniewicz ML, Eisner MD, Lazcano-Ponce E, et al. Comparison of urine cotinine and the tobacco-specific nitrosamine metabolite 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) and their ratio to discriminate active from passive smoking. *Nicotine Tob Res.* 2011; 13:202–208. [PubMed: 21330276]
12. Avila-Tang E, Al-Delaimy WK, Ashley DL, et al. Assessing secondhand smoke using biological markers. *Tob Control.* 2013; 22:164–171. [PubMed: 22940677]
13. Ballbè M, Martínez-Sánchez JM, Sureda X, et al. Cigarettes vs. e-cigarettes: passive exposure at home measured by means of airborne marker and biomarkers. *Environ Res.* 2014; 135:76–80. [PubMed: 25262078]
14. Jensen SB, Pedersen AM, Vissink A, et al. A systematic review of salivary gland hypofunction and xerostomia induced by cancer therapies: prevalence, severity and impact on quality of life. *Support Care Cancer.* 2010; 18:1039–1060. [PubMed: 20237805]
15. Gaalema DE, Higgins ST, Bradstreet MP, Heil SH, Bernstein IM. Using NicAlert strips to verify smoking status among pregnant cigarette smokers. *Drug Alcohol Depend.* 2011; 119:130–133. [PubMed: 21652155]
16. Marrone GF, Shakleya DM, Scheidweiler KB, Singleton EG, Huestis MA, Heishman SJ. Relative performance of common biochemical indicators in detecting cigarette smoking. *Addiction.* 2011; 106:1325–1334. [PubMed: 21438939]
17. Yeh E, Levasseur G, Kaiserman MJ. Evaluation of urinary cotinine immunoassay test strips used to assess smoking status. *Nicotine Tob Res.* 2011; 13:1045–1051. [PubMed: 21778149]
18. Lee A, Gin T, Chui PT, et al. The accuracy of urinary cotinine immunoassay test strip as an add-on test to self-reported smoking before major elective surgery. *Nicotine Tob Res.* 2013; 15:1690–1695. [PubMed: 23516325]
19. Warren GW, Alberg AJ, Kraft AS, Cummings KM. The 2014 Surgeon General's report: The Health Consequences of Smoking-50 Years of Progress: A paradigm shift in cancer care. *Cancer.* 2014; 120:1914–1916. [PubMed: 24687615]
20. Marin VP, Pytynia KB, Langstein HN, Dahlstrom KR, Wei Q, Sturgis EM. Serum cotinine concentration and wound complications in head and neck reconstruction. *Plast Reconstr Surg.* 2008; 121:451–457. [PubMed: 18300961]
21. Flouris AD, Chorti MS, Poulianiti KP, et al. Acute impact of active and passive electronic cigarette smoking on serum cotinine and lung function. *Inhal Toxicol.* 2013; 25:91–101. [PubMed: 23363041]
22. Etter JF. Levels of saliva cotinine in electronic cigarette users. *Addiction.* 2014; 109:825–829. [PubMed: 24401004]
23. Hajek P, Etter JF, Benowitz N, Eissenberg T, McRobbie H. Electronic cigarettes: review of use, content, safety, effects on smokers and potential for harm and benefit. *Addiction.* 2014; 109:1801–1810. [PubMed: 25078252]
24. Acosta MC, Buchhalter AR, Breland AB, Hamilton DCP, Eissenberg T. Urine cotinine as an index of smoking status in smokers during 96-hr abstinence: comparison between gas chromatography/mass spectrometry and immunoassay test strips. *Nicotine Tob Res.* 2004; 6:615–620. [PubMed: 15370157]
25. Schepis TS, Duhig AM, Liss T, et al. Contingency management for smoking cessation: enhancing feasibility through use of immunoassay test strips measuring cotinine. *Nicotine Tob Res.* 2008; 10:1495–1501. [PubMed: 19023841]

Table 1

Assessment of the Validity of Self-Reported Tobacco Use during the Prior 48 Hours Compared to the Urinary Cotinine Test with Measurements Taken on the Day of Surgery among 108 Head and Neck Cancer Patients.

(a) Observed Results.				
Self-reported Tobacco Use in the Past 48 Hours	Urinary Cotinine		Total	Predictive Values
	Positive (n = 46)	Negative (n = 59)		
Yes	28	1	29	PPV 28/29 = 96.6% (95% CI, 82.2-99.9)
No	18	61	79	NPV 61/79 = 77.2% (95% CI, 66.4-85.9)
Total	46	62	108	
Measures of test validity	Sensitivity 28/46 = 60.9% (95% CI, 45.4-74.9)	Specificity 61/62 = 98.4% (95% CI, 91.3-100.0)		

(b) Results Using Self-reported Nicotine Exposure as the Outcome.				
Self-reported Nicotine Exposure in the Past 48 Hours	Urinary Cotinine		Total	Predictive Values
	Positive	Negative		
Yes	35	9	44	PPV 35/44 = 79.6% (95% CI, 67.6-91.5)
No	11	53	64	NPV 53/64 = 82.8% (95% CI, 71.3-91.1)
Total	46	62	108	
Measures of test validity	Sensitivity 35/46 = 76.1% (95% CI, 61.2-87.4)	Specificity 53/62 = 85.5% (95% CI, 74.2-93.1)		

Abbreviations: NPV, negative predictive value; PPV, Positive Predictive Value.