Validating a Dipstick Method for Detecting Recent Smoking


Abstract

This report evaluates the validity of a new method for verifying self-reported smoking status in patients presenting for pulmonary medicine treatment. A prospective comparison was made between self-reports of smoking status and a new semiquantitative, enzyme-linked, immunosorbent assay-based method testing for the presence of a prime nicotine metabolite, cotinine. Results were validated by gas chromatography/mass spectrometry. Data were collected in an urban, academic, tertiary health care setting. The study included 76 consecutive new patients presenting to participating clinical practices at the Pulmonology or Thoracic Surgery Services. Before taking a smoking history, patients were informed that their urine would be tested onsite for the presence of nicotine using a new method, the NicoMeter, for determining tobacco product exposure, followed by more standard laboratory testing. The level of agreement between the biochemical measurement types was excellent, \( \kappa = 0.777 \). The new biochemical measurement type used was easy to use. Self-reported smoking status corresponded closely to biochemical testing. However, there was a 5.3–9.5% misclassification of smoking status among the group studied, depending upon the measurement type used. Among 32 lung cancer patients, 15.6%, most likely misrepresented their current smoking status. The NicoMeter appears to be a valid and useful method for confirming self-reported smoking status. Lung cancer patients had a higher rate of inaccurate nonsmoking compared with patients with nonmalignant pulmonary disease. The findings have implications for investigators who accept self-reported smoking status without biochemical verification.

Introduction

Studies investigating the effects of smoking cessation on long-term survival of cancer patients typically rely upon self-reported smoking status for estimations of risk (1–4). However, self-reports of smoking status used in estimating risk may not always be reliable, particularly in situations where smokers feel under strong pressure to give up smoking but have not been able to achieve abstinence (5–7).

This report evaluates the validity of a new method for verifying self-reported smoking status in patients presenting for pulmonary medicine treatment. As part of taking a smoking history, participants were informed beforehand that their urine would be tested for nicotine metabolites using the NicoMeter dip-stick test for onsite readings, followed by more conventional laboratory testing. The findings could have bearing on the measures used to correctly classify smoking status. The University of Pennsylvania Institutional Review Board reviewed and approved the project.

Materials and Methods

Subjects. The participants were 80 consecutive new outpatients seen at the offices of five specialists, three pulmonologists, and two thoracic surgeons, at the Hospital of the University of Pennsylvania. As part of standard clinical practice, all new patients were screened by masters’ level clinicians to identify current smoking status for general health reasons. Eighty patients were screened. Four patients were excluded from the analysis because they were either unable to give a urine specimen (purported never-smoker and current smoker) or refused to give a sample (purported lifetime smoker and current smoker). The analyzed group (100) was 57.9% (64) men and 42.1% (n = 36) women. Ninety-four percent were Caucasian and 6% were African-American. The mean age was 59 \pm 15.38 years. The overall prevalence of current self-reported smoking in the group was 21.1% (n = 16), with 81.6% (n = 62) of the group having smoked >100 cigarettes in their lifetime. The cancer prevalence was 46% (n = 35), of which 32 were lung cancer patients.

Procedures. Participating physicians agreed to incorporate urine testing for nicotine exposure into their standard practice. Signs were posted in the waiting rooms of all participating offices indicating that all new patients would be tested for tobacco smoke exposure free of charge.

A member of the study team restated the information from the signs before taking a smoking history. Patients were specifically asked about their lifetime smoking history including any smoking in the last week and the number of cigarettes typically smoked per day. A nonobserved urine sample was obtained in a urine collection cup for onsite testing. Most of the sample was transferred to a cryotube for freezing and later for testing using GC/MS.3

For purposes of comparing self-reports with biochemical test results, we classified those who had smoked <100 cigarettes in their lifetime as “never smokers” and those who had smoked 100 or more cigarettes in their lifetime as “lifetime

3 The abbreviation used is: GC/MS, gas chromatography/mass spectrometry.
smokers.” We classified those who had smoked within the past 7 days as “current smokers.”

**Cotinine Analyses.** Cotinine has a much longer half-life (~20 h) than nicotine (~2 h) and thus is considered a more useful marker in assessing tobacco use (8). Cotinine can be measured in biological fluids such as saliva, plasma, and urine. The NicoMeter is an immunoassay, semiquantitative method that uses a dipstick device to measure the level of cotinine in a sample of urine based on a colorimetric reaction. The sensitivity and specificity of the urine dipstick NicoMeter method has compared favorably to the ELISA laboratory method (9) and to the “gold standard” GC/MS method. The upper limit for detecting recent smoking using cotinine is generally up to 1 week (10).

Urine samples were collected and read on site by a trained clinician according to the manufacturer’s instructions. The test strip has seven zones. Each zone represents a range of cotinine/smoking (e.g., zone 0, 0–100 ng/ml, a nonsmoker; to zone 6, >10,000 ng/ml, a very heavy smoker; Ref. 9). A second blinded scorer (P. G.) confirmed the readings. Remaining urine was frozen (~80°C) for later confirmation with GC/MS.

Frozen analyses were performed at the Toxicology Laboratory at the Philadelphia Department of Veterans Affairs Medical Center. Unlike the ELISA method for detecting the presence or absence of smoking by measuring both cotinine and other cotinine metabolites, the GC/MS method directly measures only cotinine. GC/MS is presumed to be virtually 100% accurate (11, 12).

The level for passive smoke exposure or food products containing nicotine is generally well below 50 ng/ml (13, 14). The GC/MS threshold used to distinguish smokers from nonsmokers was ≥50 ng/ml (14, 15).

**Note.** Different thresholds for cutoffs are method dependent because of differences in biological fluids, the method of analysis, and the metabolite(s) being measured (e.g., for urine cotinine, the NicoMeter cutoff score is ≥100 ng/ml, compared with a standard GC/MS cutoff score of ≥50 ng/ml).

**Results**

The agreement between the NicoMeter and GC/MS readings based on 74 comparable samples was 90.5%, with 90.5% agreement on positive readings (sensitivity) and 90.6% agreement on negative readings (specificity). Sample stability of agreement on positive readings (sensitivity) and 90.6% agreement on negative readings (specificity). Sample stability of agreement on positive readings (sensitivity) and 90.6% agreement on negative readings (specificity). Sample stability of agreement on positive readings (sensitivity) and 90.6% agreement on negative readings (specificity). Sample stability of agreement on positive readings (sensitivity) and 90.6% agreement on negative readings (specificity).

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The concordance of the NicoMeter test with GC/MS was excellent. The new biochemical measurement test was easy to use, relatively inexpensive (approximately $5/specimen compared with approximately $141/specimen for GC/MS), and appears to be a valid method for confirming smoking status. Self-reported smoking status corresponded closely to biochemical testing. The prime difficulty we noticed with the NicoMeter test was determining which zone (level) reflected the actual test result. Therefore, we used the test as a qualitative measure (positive versus negative). There was no instance in which there was a questionable discrepancy between a smoking versus not smoking score. There was some evidence to suggest that the NicoMeter may fail to register lower levels of smoking. Nevertheless, the NicoMeter compared favorably with GC/MS.

Overall, in the presence of announced testing for current cigarette smoking, there appeared to be modest evidence of misrepresentation. Interestingly, there was some evidence of claimed never-smokers most likely being smokers, as also was noted in a study conducted by Pérez et al. (16). More typically, the most accurate account of possible misrepresentation is the percentage of lifetime smokers claiming to be abstinent when testing indicates otherwise. In our sample, this percentage was only 9.7%. Among lung cancer patients, it was 16.1%.

Similar to the Jarvis et al. (17) and Ockene et al. (18) studies, there was an apparent tendency toward misrepresentation, even in the presence of announced testing. The higher rate suggests reluctance/embarrassment to present risky behavior. Furthermore, although the presence of known testing tends to decrease the possible misrepresentation of smoking status (5–7), it should not be assumed that the absence of testing would produce comparable minimal levels of misrepresentation. Rather, it must be assumed that there would be an even higher rate of misrepresentation in the absence of announced testing.

It is unlikely that cotinine levels in our biochemically tested sample, using method-appropriate cutoff scores, were the result of environmental tobacco exposure. The findings do point to the need to ask patients whether they have been using a nicotine replacement product before testing and not to accept self-reported nonsmoking as completely accurate.

Obvious limitations of this study were the lack of a comparison group (announced testing versus unannounced testing) and the small sample size. Future studies might evaluate the difference in misclassification among patients who are informed of testing for nicotine exposure and those who are unaware of such testing. Additionally, no comparison was made between the two methods.

**Discussion**

The concordance of the NicoMeter test with GC/MS was excellent. The new biochemical measurement test was easy to use, relatively inexpensive (approximately $5/specimen compared with approximately $141/specimen for GC/MS), and appears to be a valid method for confirming smoking status. Self-reported smoking status corresponded closely to biochemical testing. The prime difficulty we noticed with the NicoMeter test was determining which zone (level) reflected the actual test result. Therefore, we used the test as a qualitative measure (positive versus negative). There was no instance in which there was a questionable discrepancy between a smoking versus not smoking score. There was some evidence to suggest that the NicoMeter may fail to register lower levels of smoking. Nevertheless, the NicoMeter compared favorably with GC/MS.

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*From an unpublished doctoral dissertation by P. Dunphy (5/2000).*
made with other comparable products such as NicCheck 1 or NicAlert because it was beyond the scope of the study. Of note, NicAlert can be used to determine cotinine concentrations with both urine and saliva.

Our preliminary evidence, along with findings from the health care literature, does suggest that large cohort studies evaluating disease outcomes related to smoking should consider incorporating objective measurement for confirming self-report when assessing risks from smoking. Our data suggest that misclassification may affect determinations of smoking-related relative risk in nonsmokers. Furthermore, positive readings in the presence of claimed abstinence provide an opportunity to discuss the risks of continued smoking with a vulnerable population who may benefit from counseling.

References
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