RESEARCH LETTERS

How to Measure Secondhand Smoke Exposure in a Pediatric Clinic Setting

There has been a recent focus to decrease environmental tobacco smoke (ETS) exposure among children,[1,2] but an important obstacle to overcome is how to accurately measure ETS exposure. Standardized questionnaires are associated with a high frequency of underreporting.[3,4] Cotinine, a biomarker for tobacco exposure, appears to be a more promising method to accurately detect ETS exposure,[5] but testing is currently expensive and results are not immediately available. We conducted a study to evaluate the use of a urine dipstick to measure cotinine as an alternative to the current complex testing.

Methods. Patients between the ages of 5 and 15 years and their smoking or nonsmoking caregiver who attended a busy urban Pediatric Pulmonary Clinic during February and March of 2010 were invited to participate in the study. The protocol was approved by the University of South Florida institutional review board.

The caregiver completed a smoking behavior questionnaire and a random urine sample was collected from the child to measure cotinine levels using Nymox TobacAlert test strips (Nymox Pharmaceutical Corporation, Saint-Laurent, Quebec, Canada). A level of 0 (0-6 ng/mL) represents no smoke exposure, levels of 1 (6-30 ng/mL) and 2 (30-100 ng/mL) represent secondhand smoke exposure, and levels of 3 to 6 (>100 ng/mL) represent a smoker.

Descriptive statistics were used to summarize smoking behavior, and group comparisons between smoking households and nonsmoking households were tested by Fisher exact test or χ^2 test for the categorical data or by 2-sample *t* test for the continuous data.

Results. Of the 47 patients eligible for the study, 35 were enrolled. The most common reason for not enrolling was that the child had already voided. Approximately 77% of the population was white and 23% were black, with 26% of Hispanic ethnicity. Medicaid was the primary insurance for 51% of the patients. There were no significant differences in the demographics of the smoke-exposed and non–smoke-exposed children. The mean (SD) age of participants was 9 (3) years, with 50% of the population being male. The Smoking Behavior Questionnaire results are summarized in the **Table**. Of 17 patients living with a smoker, the most common family member who smoked was the mother (70%). Urine cotinine levels did not vary based on whether the smoker was the mother or another member of the household. While 29% of children lived with more than 1 household smoker, their urine cotinine levels were not higher than those living with 1 smoker. With the exception of 1 child, who had a cotinine level of 2 ng/mL (range, 30-100 ng/mL), all cotinine levels were at level 1 (range, 6-30 ng/mL). Of 17 children living with a household smoker, 16 children had positive cotinine levels. The patient with a negative cotinine level lived in a home with an enforced smoking ban in their home and car. Of 18 patients living in a nonsmoking household, 3 patients had positive urine cotinine levels with an identifiable source of exposure (a carpool parent, a visiting uncle, and a school bathroom).

Table. Summary of the Smoking Behavior of the Household Smokers[a]

	No. (%)
No. of smokers in the household	
1	12 (70.6)
2	5 (29.4)
>2	0
Relationship to the child	
Mother only	9 (52.9)
Father only	4 (23.5)
Both mother and father	2 (11.8)
Other	2 (11.8)
Smoke in the house while child is present	
Yes	2 (11.8)
No	15 (88.2)
Smoke in the house while the child is out	
Yes	0
No	17 (100)
Smoke in the car while the child is present	
Yes	7 (41.2)
No	10 (58.8)
Smoke in the car while child is out	
Yes	12 (70.6)
No	5 (29.4)

[a] Households with smokers, n=17.

Comment. Urine cotinine test strips are a noninvasive, quick, and easy alternative to measuring urine cotinine in a busy clinic setting. Testing does not require any instrumentation or special training, and results are available in less than 15 minutes.

The test strip is a sensitive indicator of ETS exposure in both smoking and nonsmoking households; however, it is not an effective measure of small changes in urine cotinine levels. The cotinine test strips, in conjunction with a smoking behavior questionnaire, were successful in documenting the source of ETS exposure

in our study. A larger clinical trial with measurements over serial visits is needed to support the findings of this trial.

Marisa Couluris, DO
Bruce M. Schnapf, DO
Allyson Casey, ARNP
Ping Xu, MPH
Margaret Gross-King, RN, MS
Jeffrey Krischer, PhD

Author Affiliations: Divisions of Pulmonology (Drs Couluris and Schnapf and Ms Casey) and Epidemiology (Mss Xu and Gross-King and Dr Krischer), Department of Pediatrics, University of South Florida College of Medicine, Tampa.
Correspondence: Dr Couluris, University of South Florida, Department of Pediatrics, 2 Tampa Cir, 5th Floor, Tampa, FL 33505 (mcouluri@health.usf.edu).
Author Contributions: *Study concept and design:* Couluris, Gross-King, and Krischer. *Acquisition of data:* Couluris, Schnapf, and Casey. *Analysis and interpretation of data:* Couluris, Xu, and Krischer. *Drafting of the manuscript:* Couluris, Gross-King, and Krischer. *Critical revision of the manuscript for important intellectual content:* Couluris, Schnapf, Casey, and Xu. *Statistical analysis:* Xu and Krischer. *Obtained funding:* Couluris and Gross-King. *Administrative, technical, and material support:* Couluris, Schnapf, Casey, and Gross-King. *Study supervision:* Couluris and Krischer.
Financial Disclosure: None reported.
Funding/Support: The study was supported by Sun-Coast Community Clinical Oncology Program Research Base grant CA81920.

1. Committee on Substance Abuse. American Academy of Pediatrics: tobacco's toll. implications for the pediatrician. *Pediatrics*. 2001;107(4):794-798.
2. US Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health and Objectives for Improving Health*. Washington, DC: US Dept of Health and Human Services; 2000.
3. Farber HJ, Knowles SB, Brown NL, et al. Secondhand tobacco smoke in children with asthma: sources of and parental perceptions about exposure in children and parental readiness to change. *Chest*. 2008;133(6):1367-1374.
4. Boyaci H, Etiler N, Duman C, Basyigit I, Pala A. Environmental tobacco smoke exposure in school children: parent report and urine cotinine measures. *Pediatr Int*. 2006;48(4):382-389.
5. Benowitz NL. Cotinine as a biomarker of environmental tobacco smoke exposure. *Epidemiol Rev*. 1996;18(2):188-204.

Reference Range for Cerebrospinal Fluid Protein Concentration in Children and Adolescents

Elevated cerebrospinal fluid (CSF) protein concentration measured during diagnostic lumbar puncture (LP) can indicate a pathologic central nervous system process. Interpretation of CSF protein concentration requires established reference values. However, evidence-based, standardized assessments of CSF protein concentration do not exist. Ethical considerations prohibit subjecting healthy children to invasive procedures solely for research purposes. Consequently, normative values in children must be determined from diagnostic LPs.

Limitations of prior studies of CSF protein concentration in children include small sample sizes, varying inclusion and exclusion criteria, and presentation of mean and standard deviation rather than ranges.[1-6] The objective of this study was to determine age-specific reference values for CSF protein concentration.

Methods. This was a secondary analysis of a prospective cohort study performed at The Children's Hospital of Philadelphia. Subjects aged 1 to 18 years undergoing diagnostic LP were eligible. Consent from the parent and assent from the child were obtained following institutional review board approval. Subjects were screened for enrollment between January 15, 2007, and February 28, 2009, as described previously.[7]

Subjects were not approached for enrollment in the primary study of CSF opening pressure measurements if they were medically unstable or had a brain tumor.[7] Enrolled subjects with conditions that had the potential to alter CSF protein concentration (eg, meningitis, demyelinating disease) and those with CSF pleocytosis (>10 white blood cells/mm^3) or traumatic LP (>500 red blood cells/mm^3) were excluded. When a patient received multiple LPs, only results of the first LP were included.

Results. Initially, 1066 patients with LP were screened for enrollment and 439 were enrolled[7]; of these, 210 subjects remained in the study (**Table**).

The median patient age was 11.1 years (interquartile range, 5.2-14.5 years); 68 (32%) were black. The Table presents CSF protein concentrations among children in the reference group. There was an age-related increase in CSF protein concentration (eFigure, http://www.archpediatrics.com). In linear regression, CSF protein concentration increased by 0.97 mg/dL (95% confidence interval, 0.75-1.18 mg/dL; $P<.001$) for each 1-year increase in age. Comparisons across different age categories suggested that a cutoff of age 10 years was most clinically applicable (Table).

Comment. We prospectively examined CSF protein concentrations in children and adolescents to establish clinically useful reference values. These findings are important because a variety of infectious and noninfectious conditions may cause elevations in CSF protein concentrations in the absence of CSF pleocytosis.

The median and 90th percentile CSF protein concentrations in our study were higher than the values reported by Wong et al.[6] Our larger sample size may have resulted in a greater distribution of older children, which could account for these differences. The CSF protein values for children aged 1 to 9 years were comparable with a prior report.[1] It is unclear why children aged 10 to 18 years in our study had higher values than those reported by Biou et al[1] (median, 22 mg/dL; 95th percentile, 41 mg/dL).

The CSF protein concentration increased nearly 1 mg/dL for each additional year of age. The CSF protein concentration was significantly lower for subjects younger than 10 years compared with older subjects, suggesting that age 10 years may be an accurate and practical cutoff.

Children with unrecognized conditions associated with elevated CSF protein concentration may have been