

# Incidence of Passive Exposure to Crack/Cocaine and Clinical Findings in Infants Seen in an Outpatient Service

Andrew S. Lustbader, MD\*‡; Linda C. Mayes, MD\*‡; Barbara A. McGee, MD\*; Peter Jatlow, MD§; and William L. Roberts, MD, PhD||

**ABSTRACT.** *Objectives.* Passive exposure to crack/cocaine and the associated clinical symptoms may present a significant health risk to very young infants and children. This study was designed to determine the incidence of cocaine exposure, presumed to be passive, in ill infants younger than 1 year of age, using a threshold of detection for cocaine and/or its major metabolite, benzoylecognine (BE), that is lower than the current National Institute on Drug Abuse standard. The study also investigates the morbidity associated with passive cocaine exposure in this population.

*Methods.* We prospectively obtained 124 samples of urine from 122 children younger than 1 year of age for routine clinical indications from the emergency department at Yale–New Haven Hospital. Samples were analyzed by radioimmunoassay (RIA) for cocaine, with cross-reactivity for BE. The presence of BE in a portion of the RIA-positive samples also was detected in additional analyses by enzyme-multiplied immunoassay technique or by gas chromatography-mass spectrometry. A chart review was conducted on all 122 patients by reviewers blind to the urine toxicology results. Presenting complaints, symptoms, vital signs, and diagnosis were obtained for all visits before the first birthday. Birth history, including maternal drug history and birth weight, demographics, and number of medical visits in the first year, were recorded as well.

*Results.* Of the 124 samples, 45 (36.3%) were positive ( $\geq 50$  ng/mL of BE equivalents) for cocaine and/or cocaine metabolite by RIA testing. The positive results, determined by RIA, were highly correlated with patients who had lower and upper respiratory symptoms and sought medical care more often.

*Conclusions.* The incidence of unsuspected, passive cocaine exposure in ill infants seeking medical care primarily through an emergency service may be as high as 1 in 3 to 6 infants from our predominantly inner city population. Current immunoassay methods, specific for BE, and their routine threshold of detection (200 to 300 ng/mL) may not be sensitive enough to detect cocaine and BE in the urine samples of children younger than 1 year of age who are exposed passively. The development of upper and lower respiratory symptoms is correlated significantly with positive urine results in this study. The increased use of health care resources correlated with passive cocaine exposure in this sample may serve as an

indirect marker for the increased medical needs of these infants. *Pediatrics* 1998;102(1). URL: <http://www.pediatrics.org/cgi/content/full/102/1/e5>; passive exposure, crack/cocaine, respiratory illness, service utilization.

ABBREVIATIONS. SIDS, sudden infant death syndrome; BE, benzoylecognine; RIA, radioimmunoassay; NIDA, National Institute on Drug Abuse; ED, emergency department; YNHH, Yale–New Haven Hospital; EMIT, enzyme-multiplied immunoassay technique; GC-MS, gas chromatography-mass spectrometry; DPC, Diagnostic Products Corporation.

Passive exposure to crack/cocaine is recognized as a potential health hazard for young children living in households where cocaine (crack) is used,<sup>1–4</sup> although the extent and implications of the problem have not been examined thoroughly. The physiologic risks of prenatal exposure to cocaine, including intrauterine growth retardation and low birth weight, have been well established.<sup>5–12</sup> Studies of the effects of prenatal cocaine exposure on infants and young children, although inconclusive, suggest cocaine impairs arousal, attention, and stress reactivity regulation.<sup>13–16</sup> The postnatal use of cocaine by mothers or other adults in the infants' environment exposes infants and young children to crack/cocaine smoke during critical periods of brain development<sup>17</sup> and physical growth. The passive exposure to crack/cocaine smoke likely occurs in much the same way that second-hand cigarette smoke has been found to be a risk factor to infants' and children's health.<sup>18</sup> Exposure to crack smoke also may increase the risk for sudden infant death syndrome (SIDS). One study reviewed autopsies from a series of 16 instances of SIDS and found cocaine detectable in the urine, as well as evidence of past crack/cocaine exposure in the environment where each of the children were shortly before death.<sup>19</sup>

Several studies have investigated the prevalence of passive cocaine exposure in the pediatric population.<sup>1–4</sup> None have investigated in detail the morbidity associated with passive cocaine exposure in the first year of life. One study of the prevalence in children up to 5 years of age reported a rate of exposure of 5.4% but did not divide the study population into age cohorts.<sup>1</sup> A follow-up study characterized the vital signs and growth parameters of all patients in the study showing a positive correlation between the presence of benzoylecognine (BE) in patients' urine samples and growth parameters and blood pressures of those patients with positive find-

From the \*Yale Child Study Center and the Departments of ‡Pediatrics and §Laboratory Medicine, Yale University School of Medicine, New Haven, Connecticut; and the ||Department of Clinical Chemistry, University of Mississippi, Jackson, Mississippi.

Received for publication Oct 6, 1997; accepted Mar 2, 1998.

Reprint requests to (A.S.L.) Yale Child Study Center, 230 S Frontage Rd, New Haven, CT 06520-7900.

PEDIATRICS (ISSN 0031 4005). Copyright © 1998 by the American Academy of Pediatrics.

ings.<sup>2</sup> A third study listed the signs, presenting complaints, and diagnoses for 6 patients with positive urine results.<sup>3</sup> A fourth found passive exposure incidentally and gave brief case studies of the 3 patients in whom passive exposure was suspected.<sup>4</sup>

The present study was designed to determine the incidence of passive cocaine exposure based on urine testing in a general outpatient population of children younger than 1 year old presenting for sick visits to an emergency service of an inner city medical center hospital and to assess the associated morbidity. This study focused solely on infants younger than 1 year of age and used a detection threshold for cocaine or cocaine metabolites of 50 ng/mL of BE equivalents by radioimmunoassay (RIA), a threshold that is lower than the current National Institute of Drug Abuse (NIDA)-recommended guideline for adults, but may be more appropriate for a pediatric population. This lower threshold is well above the detection limits stated by the manufacturer (12.5 ng/mL). Also, the RIA procedure may be more appropriate for pediatric populations, because it shows high cross-reactivity for unmetabolized cocaine, and some infants, with less mature metabolic functions, might excrete relatively more parent drug in the urine.<sup>20</sup> Possible clinical correlates of passive cocaine exposure were examined by studying the relationship between positive urine assays for cocaine and its metabolites with the following clinical measures: 1) birth history; 2) presenting symptoms, vital signs, physical findings, and discharge diagnosis for the visit at the time urine was collected; and 3) frequency of the use of emergency department (ED) and outpatient clinic services for well and sick child care.

## METHODS

### Study Sample

The study was conducted at Yale–New Haven Hospital (YNHH) from December 1993 to September 1994. The research protocol was approved by the institutional review board and met the guidelines for investigational studies in children, including strict maintenance of confidentiality for subjects. The study samples were aliquots of urine submitted consecutively to the clinical laboratory of YNHH from any pediatric clinical site. YNHH is an urban teaching hospital with 105 inpatient, pediatric beds. Pediatric clinical sites at YNHH include the ED, primary care and subspecialty clinics, and inpatient units including newborn and pediatric intensive care facilities. The pediatric ED, with nine examining rooms, serviced a total of 15 387 patients in the 9-month study period, 2548 of whom were younger than 1 year of age. As per the normal hospital routine, physicians ordered urine samples to be obtained for clinical indications from children at all of the YNHH clinical sites. These physicians were not aware that urine samples were being screened for cocaine, and no urine samples were submitted with clinical suspicion of drug exposure. Urine samples were then delivered to the clinical laboratory at YNHH from these sites, also as part of the normal hospital routine. Urine samples were identified by the laboratory as being collected from infants, and set aside for analysis for BE and cocaine. All toxicology testing was performed anonymously, without reporting the results in patient records, thus precluding the need for parental consent for participation in the study.

A total of 296 samples were collected over a 9-month study period. This sample size was estimated prospectively as a number higher than that necessary to ensure the appropriate level of significance in data analysis. Of these samples, 48 were discarded after it was determined that the child was older than 12 months at the time of the urine collection, leaving 248 samples submitted to the laboratory for analysis. Samples were identified in the labora-

tory by the child's name, hospital number, date of birth, and clinical site of collection. All identifying material was removed from the sample, which was then given a separate study number, and samples were frozen at  $-70^{\circ}\text{C}$  before analysis.

Of the 248 samples analyzed for cocaine and cocaine metabolites, 119 were obtained from inpatients. These samples were discarded from additional study because the length of hospital stay was quite varied; most of these 119 children had been hospitalized for longer than 2 or 3 days, the length of time that cocaine and its metabolites are reported to test positive in the urine. Of the 129 remaining samples, 124 were obtained from patients seen in the ED; the remaining 5 urine samples were submitted from primary care outpatient subspecialty clinics. The 5 samples from the subspecialty clinics were excluded because they were too small of a subset to analyze meaningfully. Two patients submitted 2 urine samples each, with the samples collected at two different visits a minimum of 72 hours apart.

These 122 children represent 4.8% of the children younger than 1 year old seen in the ED in a 9-month period. In our ED, urine samples are obtained from an average of 13.2% of children younger than 1 year of age. Furthermore, this approach of collecting urine samples for clinical indications from sick children seen in an outpatient setting is similar to the methods of other groups investigating the problem of passive cocaine exposure.<sup>1-2</sup>

### Laboratory Procedures

The urine samples were analyzed by an RIA (Diagnostic Products Corporation, Los Angeles, CA) using aqueous benzoyllecgonine calibrators of 0, 12.5, 25, 50, 100, and 300 ng/mL. Although the detection limit for this assay is reported to be 12.5 ng/mL of BE with no reported interferences by noncocaine-related compounds, we considered results positive only if results exceeded a cutoff of 50 ng/mL. Results are reported as BE equivalents. However, the cross-reactivity of this assay for unmetabolized cocaine is 4000% compared with the major urinary metabolite BE. Samples that exceeded 50 ng/mL BE equivalents were submitted to an additional immunoassay testing using enzyme-multiplied immunoassay technique (EMIT) reagents (Syva Co, Palo Alto, CA) performed on a Hitachi 717 analyzer (Boehringer Mannheim, Indianapolis, IN). Positive RIA samples with sufficient volume also were analyzed for BE by gas chromatography-mass spectrometry (GC-MS) using a cutoff of 50 ng/mL.

### Hospital Chart Review

The hospital records of 122 children seen in the ED were reviewed. Patient data from the first year of life of each subject were abstracted retrospectively from hospital charts kept by YNHH. These charts contained the records of all outpatient and ED visits as well as the birth record. Charts were reviewed by three research assistants who were trained by two of the authors (AL and LM). The reviewers were unaware of the urine toxicology results for each child. Subject anonymity was maintained through a system of identification by study number, unique from the hospital identification numbering system. The study numbers were used to match the chart review information with urine results during data analysis by one of the authors (AL). The log linking urine results with identifying information was then destroyed in accordance with protocol approved by the institutional review board.

A data collection form was created to extract material from the charts in a standardized manner. The date on which the study urine was obtained was defined as the index visit. For the time before the child's first birthday, information was collected on 1) the child's birth history including gestational age and birth weight as well as recorded history of maternal drug use during the pregnancy; 2) the number of well child care visits throughout the first year of life; 3) the number of sick visits defined as either an unscheduled outpatient clinic visit or a visit to the ED. For the index visit, information was collected regarding presenting symptoms, vital signs, physical findings, any current medications, other laboratory tests, and discharge diagnosis. Eighty percent of charts were reviewed by two reviewers to check reliability, and any disagreements (eg, missing data) were resolved by consensus agreement.

## RESULTS

### Analysis for Cocaine and Cocaine Metabolites

Of the 124 samples from ill outpatients younger than 1 year of age, 45 (36.3%) tested positive for cocaine and/or BE by RIA at a cutoff of  $\geq 50$  ng/mL of BE equivalents. An additional 23 (18.5%) gave RIA results from 12.5 to 49 ng/mL and were considered intermediate. The remaining 56 samples (45.2%) were  $<12.5$  ng/mL and were considered negative.

Of the 45 samples testing positive by RIA ( $\geq 50$  ng/mL), 42 also were tested by EMIT using a cutoff of 12.5 ng/mL of BE. The lower cutoff was used for EMIT because this test detects essentially only BE, whereas the RIA shows much stronger reactivity with unmetabolized cocaine. Of the 42 EMIT-tested samples, 18 were positive, including all 8 tested with RIA concentrations  $>300$  ng/mL. There was sufficient urine volume to test 12 of the positive samples for BE by GC-MS. Using a 50 ng/mL of BE cutoff, 5 were positive by GC-MS testing. These results probably reflect the much higher cross-reactivity of the RIA procedure for unmetabolized cocaine, in which only 0.3 and 1.25 ng/mL of cocaine correspond to 12.5 and 50 ng/mL of BE equivalents. The lower cutoff points that we used in the EMIT and GC/MS assays were 12.5 and 50 ng/mL, respectively. Thus, by RIA analysis alone, the rate of samples positive for cocaine and BE was 36.3%. Taking into account the additional EMIT testing for BE alone, 18 (14.5%) of 124 samples were positive.

### Clinical History

For the purposes of correlating clinical history with the presence of a urine positive for cocaine metabolites, three groups based on RIA testing were defined: a negative group (RIA  $<12.5$  ng/mL;  $n = 56$ ), an intermediate group (RIA 12.5 to 49 ng/mL;  $n = 23$ ), and a positive group (RIA  $\geq 50$  ng/mL;  $n = 45$ ). Table 1 shows the demographic distribution of the sample by the three exposure groups based on the urine analyses for cocaine metabolites. In the overall sample, there were 71 boys and 51 girls; slightly more than half of the samples were Caucasian (50.8%) and another 29.0% were African-American. The mean gestational age for the overall sample was 39.0 weeks (SD, 2.7) and birth weight 3114 g (SD, 852). The mean child age at the time of the index visit for the overall sample was 3.4 months, with a range from 4 days to 11.4 months of age. Infants younger

than 4 days were not included in the sample to eliminate the potential for positive urine samples resulting from prenatal cocaine exposure.

All study subjects were older than 12 months at the time of the retrospective chart reviews. Thus, all visits to outpatient services at YNNH in the first year of life were recorded. More than two thirds of the sample (69.7%;  $n = 85$ ) had had no well child visits; conversely, all 122 children had had at least 1 sick visit and 5 (4.8%) had had more than 10 sick visits in the first year of life. The mean number of sick visits for the overall sample was 3.2 (SD, 3.7; range, 1 to 25). Because of the skewed distribution, analyses with regard to clinic visits were performed on square root-transformed data. From a review of the children's hospital records, 6 mothers reported a history of cocaine or crack use. Of the urine samples from these 6 children, 3 tested within the positive group and 1 in the intermediate range, and 2 were considered negative.

For the index visit, 79 children (63.7%) presented with gastrointestinal symptoms, 50 of whom were febrile. Thirty-eight (30.6%) presented with upper respiratory symptoms and 46 (37.1%) with lower respiratory symptoms. Twenty-three children (18.5%) had lower respiratory physical findings (eg, wheezing), 13 of whom were also febrile. Overall, 79 children (63.7%) were febrile on initial presentation, and 3 (3.8%) were tachycardiac without fever. The most common diagnosis at discharge was infection (74; 59.7%). Of these 74, 2 (2.7%) were given a lower respiratory diagnosis, and the other 72 were labeled as having unspecified viral infection. After initial outpatient evaluation, 75 study patients were admitted to the hospital for additional work-up and treatment, whereas 49 were sent home to be followed as outpatients.

### Relationship to Passive Cocaine Exposure

Table 1 shows the relationship between passive cocaine exposure and the number of sick and well visits. There were significant differences among infants with positive urine results for cocaine or cocaine metabolites and those with urine samples marginally positive or negative in health care utilization as measured by the number of sick or well visits. Children with positive urine results were significantly more likely to have both more sick and well visits than were children in the group with either

TABLE 1. Demographic Characteristics of Sample ( $N = 124$ )

	Negative RIA $N = 56$ (SD)	Intermediate Group RIA 12.5–49 ng/mL $N = 23$ (SD)	RIA $\geq 50$ ng/mL $N = 45$ (SD)	
Child gender				
Male:female	31:25	12:11	29:16	$\chi^2 = 0.53$
Gestational age (wk)	39.2 (2.7)	39.0 (1.5)	38.8 (3.2)	$F_{(2,111)} = 0.3$
Birth weight (g)	3164 (975)	3076 (473)	3071 (825)	$F_{(2,104)} = 0.1$
Child age (mo)	2.2 (2.5)	3.6 (2.9)	4.5 (3.2)	$F_{(2,123)} = 8.2^{**}$
Mean well visits <sup>a</sup>	0.25 (.94)	0.8 (1.6)	1.8 (2.4)	$F_{(2,122)} = 9.2^{**}$
Mean sick visits <sup>a</sup>	2.5 (2.7)	2.0 (1.9)	4.7 (4.7)	$F_{(2,122)} = 5.5^*$
Mean total visits <sup>a</sup>	2.7 (3.1)	2.8 (3.1)	6.6 (6.4)	$F_{(2,122)} = 7.0^{**}$

<sup>a</sup> Data were square root-transformed and covaried for child age.

\*  $P \leq .01$ ; \*\*  $P \leq .001$ .

negative or intermediate positive urine samples; that is, they were brought to medical care more often (post hoc comparisons based on Tukey's  $b < .05$ ). All sick and well visit data were square root-transformed, and analysis was covaried for child age. There were no significant differences in visits between the intermediate and negative groups in post hoc comparisons.

Table 2 presents the relationship between passive crack/cocaine exposure and symptoms and diagnoses at the index visit. Children with urine samples positive for cocaine or cocaine metabolites or children in the intermediate group were significantly more likely than were children in the negative group to present with either upper or lower respiratory symptoms ( $\chi^2 = 6.0$ ;  $P = .05$ , and  $\chi^2 = 8.4$ ;  $P = .01$ , respectively). There was no difference in the proportion of children with positive, negative, or intermediate positive urine samples who presented with gastrointestinal symptoms. Also, there were no differences in the weight of children at the time of the index visit among the exposure groups when age and birth weight of the child was controlled for ( $F_{(2,96)} = 1.1$ ;  $P = .34$ ). Similarly, at the time of discharge from the ED, children with positive urine findings for cocaine or cocaine metabolites were no more likely to have a diagnosis of either a respiratory or a viral infection than were those with negative or intermediate positive findings. In 31.3% of infants with a positive RIA, physicians considered a diagnosis of sepsis and pursued laboratory tests accordingly. However, there was no significant difference in the rate of admission to the hospital among the negative (48.2%), intermediate (30.4%), and positive (29.9%) groups ( $\chi^2 = 4.6$ ;  $P = .10$ ).

## DISCUSSION

In a general ED population of ill children younger than 1 year of age, between 1 in 3 and 1 in 6 children have evidence by urine assay of exposure to cocaine, presumably through passive exposure to smoked cocaine (crack). These children who have been passively exposed to cocaine appear in health care facilities more frequently for both sick and well child visits. In particular, among children who have been apparently exposed passively to cocaine, there is a significant increase in the incidence of upper and lower respiratory symptoms, with or without accompanying fever.

Several investigators have reported a notable but lower incidence of passive cocaine/crack exposure among infants and young children.<sup>1-4</sup> In contrast to

our methods, assays used by previous researchers measured only BE, without measuring free cocaine, and higher thresholds of detection were used for designating the positive urine samples in the past. Previously, there had been minimal clinical correlation made in studies of passive cocaine exposure.

Kharasch et al<sup>3</sup> reported a 2.4% positive rate for cocaine exposure using a BE concentration of 300 ng/mL by EMIT as the threshold for positivity as recommended by NIDA. The age range sampled was 2 weeks to 5 years, and there were 250 urine samples. This study also noted the chief complaint, vital signs, and diagnoses of the 6 patients whose samples were positive for BE. However, no correlation was made between the clinical parameters and rates of cocaine positivity.

Two prevalence studies have been performed by Rosenberg and colleagues. Both used a threshold of positivity of 50 ng/mL of BE for the EMIT assay. The first study evaluated further the samples that were positive by EMIT using RIA. The second study verified the EMIT-positive urine samples by fluorescence polarization immunoassay with the same cut-off. In both studies, samples were considered positive only if both the EMIT and the supplemental test results were positive. Also in both studies, the age ranges were from 1 to 60 months and, as in our study, urine was obtained only from patients in whom urinalysis was required for investigation of the chief complaint. In the earlier study,<sup>1</sup> the sample size was 460 children, and BE was identified and confirmed in 25 (5.4%) of the samples. There was no clinical correlation attempted in the first Rosenberg study. In the later study,<sup>2</sup> 41 (4.4%) of the 942 samples of urine were found to be confirmed positive for BE. In addition, positive correlations were found between BE presence in patients' urine samples and growth parameters and blood pressures of those positive patients.

A fourth study<sup>4</sup> involved 1680 consecutive urine samples from 1120 pediatric patients, analyzing more than one urine sample per patient in some cases. Forty-nine patients (4.4%) had urine samples positive for BE by immunoassay at 300 ng/mL. Of these, only 7 patients were younger than adolescence: 4 were neonates and 3 patients were 1 to 7 months of age, with 1 being breastfed. Brief case studies of these latter 3 patients were presented as part of the paper; 1 infant presented with episodes of staring and unresponsiveness, another with apnea and limpness, and the third was seen for well child

**TABLE 2.** Symptoms and Diagnoses at Index Visit ( $N = 124$ )

Presenting Symptoms <sup>a</sup>	Negative RIA $N = 56$	Intermediate Group; RIA 12.5-49 ng/mL $N = 23$	RIA $\geq 50$ ng/mL $N = 45$	
Upper respiratory	11 (19.6%)	10 (43.5%)	17 (37.8%)	$\chi^2 = 6.0^*$
Lower respiratory	13 (23.2%)	11 (47.8%)	22 (48.9%)	$\chi^2 = 8.4^{**}$
Gastrointestinal	36 (64.3%)	15 (65.2%)	28 (62.2%)	$\chi^2 = .07$
Diagnoses				
Infection	33 (58.9%)	12 (52.2%)	12 (26.7%)	$\chi^2 = 0.9$

<sup>a</sup> Infants may have had one or more presenting symptoms simultaneously.

\*  $P \leq .05$ ; \*\*  $P \leq .01$ .

care. All 3 were discharged home in stable condition after evaluation by social services.

The high incidence of apparent passive exposure to crack/cocaine in the present study may be the result of three specific characteristics of our study. First, all subjects were recruited through an inner city clinic and ED, primarily serving a high-risk population of children and families. Second, the young children from whom urine samples were obtained were all being seen for sick visits in which the physician felt it necessary to obtain a urine sample for clinical reasons. Third, in contrast to other studies, we used a lower threshold for positivity and a more sensitive test, the RIA, which detects unmetabolized cocaine as well as the major metabolite BE.

Approximately 14% to 17% of women receiving prenatal care at YNHH report cocaine use during pregnancy.<sup>20</sup> However, it is not clear how the patient population served by the YNHH ED and clinics may differ from that of other university hospital-based programs in mid-size cities in the Northeast. Specific numbers for the prevalence of drug use in this population of patients is thought to be comparable with other inner city hospital catchment areas, with a mixture of patients from diverse ethnic and socioeconomic backgrounds. If there were an overall greater prevalence of cocaine use in the population served by the YNHH ED, this may account for some of the increase in exposure documented by the present study compared with previous reports.

In this study, urine samples were taken from sick infants when urinalysis was necessary for investigation of the chief complaint. This introduces a sampling bias, favoring the study of a sicker population of patients, with increased potential for hospitalization, over the larger group of patients seen in the outpatient setting. Similarly, although the physicians were not aware that toxicology screening was being performed, the decision to pursue more extensive studies often is influenced by many factors that contribute to the overall clinical picture. In this case, physicians may have pursued a more extensive work-up if they suspected substance abuse in the family, a clinical suspicion usually not documented in the child's chart. Using this sampling method may introduce an inherent bias that cannot be explained fully. However, this method of data collection was similar to that used in the Rosenberg studies. It is unclear whether cocaine exposure alone may account for the increased level of acuity in this population. If so, cocaine exposure may independently predispose the patients toward undergoing more extensive evaluations in the ED. Additional investigation is needed to obtain a more accurate picture of overall cocaine exposure in the general population of infants seen in outpatient settings. Ideally, urine samples would be collected from all patients at a site, regardless of the initial clinical work-up pursued. This approach would reduce the potential bias of studying only infants for whom more extensive work-ups were obtained.

Another reason for the higher reported cocaine exposure in this study may be the greater sensitivity of detection methods used. The cross-reactivity of

cocaine in the DPC RIA is 4 000%; thus, only 5 ng/mL of cocaine is equivalent to 200 ng/mL of BE. Most other immunoassays, including the Syva EMIT method, detect only BE and not cocaine. In the present sample, there were 8 samples with RIA results  $\geq 300$  ng/mL that also were tested by the EMIT assay. The EMIT results for all 8 were between 50 and 300 ng/mL. In addition, the 11 samples with the highest RIA results ( $\geq 300$  ng/mL) had GC-MS values for BE that ranged from below the 50 ng/mL cutoff (2 samples) to 50 to 150 ng/mL (9 samples). Therefore, all of the EMIT and GC-MS positive results would have been interpreted as negative by current NIDA standards. Considering such results, the present study may support increased use of urine analysis techniques that detect free cocaine, as well as cocaine metabolites, in the urine of infants younger than age 1. The RIA technique may serve well as a screening test in infants because of some evidence that infants metabolize cocaine less efficiently.<sup>21</sup> Lower esterase activities in immature liver may result in lower detectable levels of BE and higher concentrations of unmetabolized cocaine in the urine of infants and young children, compared with adults.

The most significant clinical associations for the group with positive findings was with lower respiratory presenting symptoms. The increase in respiratory symptoms may be related to airway mucosa irritation from exposure to cocaine smoke. The highest correlations of clinical data with RIA results  $\geq 50$  ng/mL of BE equivalents were found for lower respiratory presenting symptoms and in the total number of sick and well child visits. Lower respiratory symptoms were significantly associated with almost half of the positive group, as well as with 47.8% of the intermediate group. In contrast, only 23.2% of the negative group presented with lower respiratory symptoms. The results for upper respiratory symptoms revealed a similar pattern (Table 2). The strong clinical similarity between the positive and intermediate groups suggests that the children within the intermediate group also may have had exposure to cocaine. We chose to be conservative in not selecting a lower cutoff for a positive urine BE result because the high sensitivity and cross-reactivity of the RIA for unmetabolized cocaine precluded ready confirmation. Thus, a significant proportion of the children in the intermediate group also may have been exposed to cocaine, which may explain their clinical similarity to the positive group.

A limitation of the present study was the lack of information obtained through the infant chart regarding nicotine cigarette smoke exposure in the home. These data are not usually obtained at the time of a brief clinical encounter and are not recorded routinely in the hospital chart. However, there is generally a higher incidence of cigarette smoke among crack/cocaine abusers. The same mechanism, paralysis of the mucosal cilia, may be responsible for the increase in respiratory symptoms seen with both nicotine and cocaine smoke. In either case, the risk of SIDS may be increased.<sup>19,22</sup> In families with drug-abusing caretakers, attention to infants

and children is likely to be less diligent and also may lead to an increase in potentially serious events, such as apnea, going unnoticed.

The findings suggest that those infants who have increased exposure to cocaine utilize public health care resources more often. Conversely, as suggested by the increased number of well child visits for the cocaine-exposed group, increased health care utilization may be an indirect marker of concern about the infant and of the infant's need for medical attention potentially attributable to respiratory symptomatology. However, in this study, data on the other sources of outpatient care during the first year of life were not available. It is possible that the group with fewer well child visits may receive their primary health care elsewhere, as with private physicians, and therefore would have fewer well child visits recorded in the hospital chart.

Notably, there is a disparity between the high incidence of infant cocaine exposure and the lack of significant numbers of positive maternal drug histories in the mothers of those patients who are positive for cocaine. Medical record reviews are consistently unreliable sources of information regarding maternal drug use and, thus, these data must be viewed with some caution. They surely underestimate the percentage of mothers in the present study who are active cocaine users, potentially exposing their infants to crack smoke. Alternatively, children may be exposed directly to cocaine through breastfeeding or through direct oral cocaine being given to the infant, without such issues being brought forth in the medical interview. In our sample, data on breastfeeding were not available for one third of the subjects. Of the 88 subjects for whom information was available, 40 were breastfed during the first year of life, and 48 were not breastfed. Twenty-seven percent of children with positive urine findings were reported to have been breastfed, compared with 22% in the intermediate group and 42% of the negative group ( $\chi^2 = 4.1$ ;  $P = .13$ ). This difference was not found to be statistically significant. It is important to note that there are many sources of passive exposure to cocaine that do not necessarily implicate the mother as the user. Partners, friends, and other family members who are users may expose the infant by smoking in the household. In any event, by relying solely on historical reporting, health care providers may be missing important clinical information regarding a hazardous environmental contaminant for children.

Specific recommendations regarding when to test children for cocaine exposure in an outpatient setting cannot be answered by the present study. ED visits with upper and lower respiratory symptoms as well as rule-out sepsis work-ups in children younger than 1 year old might warrant a urine toxicology screen, if more sensitive testing were to become the standard of care. Automatic reporting to a child welfare agency might often misidentify the mother as the cocaine user, because exposure may occur through other persons in the child's environment. In addition, the sequelae of chronic postnatal exposure to cocaine have not been specifically identified. With these caveats in mind, and after additional study, exposure

to cocaine in itself or as a marker for environmental risks for children may warrant thoughtful reporting to child welfare agencies. Studies of infants living in cocaine-abusing households to date have suggested a higher incidence of failure to thrive as well as increased abuse and neglect.<sup>23</sup> Also, in some infants who have died from SIDS, evidence of cocaine exposure has been found in their urine as well as in their environment.<sup>19</sup> Environmental cocaine exposure may contribute to the effects of prenatal exposure, as well, adding to possible impairments with attention and arousal in these infants.<sup>24</sup> Larger samples are needed to define the predictors of a positive urine sample for cocaine in children and how this relates to overall morbidity in a wider population.

We conclude that passive exposure to smoked cocaine may have clinically significant effects on children younger than 1 year old and may increase their risk for chronic and acute respiratory illnesses. It may be appropriate to use assays adapted to lower detection limits for cocaine and its metabolites in this particular risk group. Alternatively, or in addition, passive exposure to cocaine may be an indicator of other undetermined risk factors, such as exposure to nicotine smoke,<sup>18</sup> other drug use,<sup>15</sup> and/or neglect,<sup>23</sup> which may account for the acute clinical presentations of children with positive urine findings for cocaine. Additional study also may clarify the clinical significance of passive cocaine exposure. The challenge of how to protect these infants who are at significant health and social risk represents an important public health problem.

#### ACKNOWLEDGMENTS

This work was supported in part by Yale Children's Clinical Research Center Grant M01-R06022, the General Clinical Research Centers Program, and the National Center for Research Resources, National Institutes of Health. Dr Mayes' involvement in this research was supported in part by NIDA Grant RO1 DA06025 and Research Scientist Development Award KO2 from NIDA.

We gratefully acknowledge the assistance of the personnel of the YNH clinical laboratories in ensuring that samples were collected and stored properly. We acknowledge the efforts of Lyla Johnson and Edwina Landau in their careful review of the children's medical records. As well, we are grateful to Kelly Reynolds for her work in performing the RIA urine assays. We also thank Diagnostic Products Corporation for donating the RIA kits.

#### REFERENCES

1. Rosenberg N, Meert K, Knazik S, et al. Occult cocaine exposure in children. *Am J Dis Child.* 1991;145:1430-1432
2. Rosenberg N, Meert K, Marino D, et al. Occult cocaine and opiate exposure in children and associated physical findings. *Pediatr Emerg Care.* 1995;11:167-169
3. Kharasch S, Vinci R, Glotzer D, et al. Unsuspected cocaine exposure in young children. *Am J Dis Child.* 1991;145:204-206
4. Shannon M, Lacouture P, Roa J, Woolf A. Cocaine exposure among children seen at a pediatric hospital. *Pediatrics.* 1989;83:337-341
5. Coles CD, Platzman KA, Smith I, James ME, Falek A. Effects of cocaine and alcohol use in pregnancy on neonatal growth and neurobehavioral status. *Neurotoxicol Teratol.* 1992;14:23-33
6. Little BB, Snell LM. Brain growth among fetuses exposed to cocaine in utero: asymmetrical growth retardation. *Obstet Gynecol.* 1991;77:361-364
7. Fulroth R, Phillips B, Durand DJ. Perinatal outcome of infants exposed to cocaine and/or heroin in utero. *Am J Dis Child.* 1989;143:905-910
8. Hadeed AJ, Siegel SR. Maternal cocaine use during pregnancy: effect on the newborn infant. *Pediatrics.* 1989;84:205-210. See comments
9. Jacobson J, Jacobson S, Sokol R, et al. Effects of alcohol, smoking, and illicit drugs on fetal growth in black infants. *J Pediatr.* 1994;124:757-764
10. Kliegman RM, Madura D, Kiwi R, Eisenberg I, Yamashita T. Relation of

- maternal cocaine use to the risks of prematurity and low birth weight. *J Pediatr*. 1994;124:751–756
11. Zuckerman B, Frank DA, Hingson R, et al. Effects of maternal marijuana and cocaine use on fetal growth. *N Engl J Med*. 1989;320:762–768
  12. Petitti DB, Coleman C. Cocaine and the risk of low birth weight. *Am J Public Health*. 1990;80:25–28
  13. Mayes LC, Bornstein MH. Developmental dilemmas for cocaine-abusing parents and their children. In: Lewis M, Bendersky M, eds. *Mothers, Babies, and Cocaine: The Role of Toxins in Development*. Hillsdale, NJ: Lawrence Erlbaum Associates; 1995:251–272
  14. Frank DA, Bresnahan D, Zuckerman BS. Maternal cocaine use: impact on child health and development. *Adv Pediatr*. 1993;40:65–99
  15. Richardson GA, Day NL, McGauhey PJ. The impact of prenatal marijuana and cocaine use on the infant and child. *Clin Obstet Gynecol*. 1993;36:302–318
  16. Singer L, Farkas K, Kliegman R. Childhood medical and behavioral consequences of maternal cocaine use. *J Pediatr Psychol*. 1992;17:389–406
  17. Mayes LC. Neurobiology of prenatal cocaine exposure: effect on developing monoamine systems. *Infant Mental Health*. 1994;15:134–145
  18. Neas LM, Dockery DW, Ware JH, Spengler JD, Ferris BG Jr, Speizer FE. Concentration of indoor particulate matter as a determinant of respiratory health in children. *Am J Epidemiol*. 1994;139:1088–1099
  19. Mirchandani H, Mirchandani I, Hellman F, et al. Passive inhalation of free-base cocaine (“crack”) smoke by infants. *Arch Pathol Lab Med*. 1991;115:494–498
  20. Kain ZN, Mayes LC, Ferris CA, Pakes J, Schottenfeld R. Cocaine-abusing parturients undergoing cesarean section. A cohort study. *Anesthesiology*. 1996;85:1028–1035
  21. Stewart DJ, Inaba I, Lucassen M, Kalow W. Cocaine metabolism: cocaine and norcocaine hydrolysis by liver and serum esterases. *Clin Pharmacol Ther*. 1979;25:464–468
  22. Kandall SR, Gaines J, Habel L, Davidson G, Jessop D. Relationship of maternal substance abuse to subsequent sudden infant death syndrome in offspring. *J Pediatr*. 1993;123:120–126
  23. Ryan DO, Ehrlich SM, Finnegan LP. Infants of drug addicts: at risk for child abuse, neglect, and placement in foster care. *Neurotoxicol Teratol*. 1987;9:315–319
  24. Mayes LC, Bornstein MH, Chawarska K, Haynes OM, Granger RH. Impaired regulation of and arousal in 3-month-old infants exposed prenatally to cocaine and other drugs. *Dev Psychopathol*. 1996;8:29–42

**Incidence of Passive Exposure to Crack/Cocaine and Clinical Findings in Infants Seen in an Outpatient Service**

Andrew S. Lustbader, Linda C. Mayes, Barbara A. McGee, Peter Jatlow and William L. Roberts

*Pediatrics* 1998;102:e5

DOI: 10.1542/peds.102.1.e5

**Updated Information & Services**

including high resolution figures, can be found at:  
<http://pediatrics.aappublications.org/content/102/1/e5>

**References**

This article cites 22 articles, 1 of which you can access for free at:  
<http://pediatrics.aappublications.org/content/102/1/e5#BIBL>

**Subspecialty Collections**

This article, along with others on similar topics, appears in the following collection(s):

**CME**

<http://www.aappublications.org/cgi/collection/cme>

**Permissions & Licensing**

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:

<http://www.aappublications.org/site/misc/Permissions.xhtml>

**Reprints**

Information about ordering reprints can be found online:

<http://www.aappublications.org/site/misc/reprints.xhtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



# PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

## **Incidence of Passive Exposure to Crack/Cocaine and Clinical Findings in Infants Seen in an Outpatient Service**

Andrew S. Lustbader, Linda C. Mayes, Barbara A. McGee, Peter Jatlow and William L. Roberts

*Pediatrics* 1998;102:e5

DOI: 10.1542/peds.102.1.e5

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/102/1/e5>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 1998 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

