

Prediction of Impairment from Urine Benzoylecgonine Concentrations

To the Editor:

One of the functions of the forensic toxicologist is to interpret analytical findings generated by the laboratory. In postmortem cases, this interpretation involves the potential role of the identified substances in the cause of death of an individual. In living individuals, an assessment of toxicity or impairment is often required. With the notable exception of ethanol, attempts to correlate impairment with drug concentrations have been limited. The Drug Evaluation and Classification program (1) was developed to combine physical effects displayed by an individual with toxicology results to assess impairment. The observations of a trained drug recognition expert consistent with the use of a particular drug class in combination with the presence of the drug in the blood or urine is usually sufficient to sustain charges of driving under the influence of drugs. Both a behavioral component and an analytical component are necessary in the final determination of impairment.

Nevertheless, forensic toxicologists are occasionally asked to make assessments about impairment without the advantage of a behavioral component. For example, a decision several years ago by the United States Court of Appeals for the Armed Forces (2) stated that, in drug testing cases, the government's expert testimony should show "... that the cutoff level and reported concentration are high enough to reasonably discount the possibility of unknowing ingestion and to indicate a reasonable likelihood that the user at some time would have "experienced the physical and psychological effects of the drug..."

In other words, absent any observations of impairment, the government expert was expected to interpret impairment merely from the concentration of a drug or metabolite in urine. Although this opinion has been modified by subsequent case law from this appellate court, the issue of assessing impairment from a urine concentration of drug or metabolite does occur in both criminal and civil litigation.

In light of this, we thought that it would be interesting to review some blood and urine data collected in postmortem cases obtained from the Office of the Chief Medical Examiner, State of Maryland and the Armed Forces Institute of Pathology. Cocaine was selected as the drug to be studied because it is detected in a large number of cases. Specifically, urine benzoylecgonine (BE) concentrations were compared with blood cocaine concentrations to ascertain whether there were any meaningful relationships between them. Although it is recognized that there was no agreed upon minimum blood cocaine concentration associated with impairment, it is generally accepted that blood is a better specimen to assess toxicity than urine. Therefore, if no relationship between blood and urine concentrations were established, then the likelihood of assessing impairment from urine concentrations is limited.

Cocaine was quantitated by gas chromatography with nitrogen phosphorus or mass spectrometric detection (3,4). BE was quantitated as the butyl derivative (5). The limit of quantitation for each compound by either method was 0.05 mg/L.

A summary of the results is provided in Table I. From the table, it can be seen that the overall trend is that as the urine BE concentration increases, there is an increased likelihood that a blood cocaine concentration greater than 0.05 mg/L will be seen. When the urine BE concentration is less than 1.0 mg/L, a blood concentration greater than 0.05 mg/L occurred less than 10% of the time. The percentage of cases with a positive blood cocaine increases as the urine BE concentration increases; however, even when the urine BE concentration exceeds 50 mg/L, there is an approximately one-in-four chance that the blood concentration is less than 0.05 mg/L.

One factor that should be considered in assessing these data is the *in vitro* instability of cocaine in blood specimens (6). Many, but not all of the specimens were analyzed for cocaine within several days after death. Data from these cases were compared with the cases in which there was a larger period of time between death and blood cocaine analysis; no significant differences were

Table I. Distribution of Blood Cocaine and Urine BE Concentrations

Blood Cocaine Concentrations (mg/L)	Urine BE Concentrations (mg/L)			
	< 1.0	1.0–10	10.1–50.0	> 50.1
< 0.05	21	44	29	9
0.05–0.20	0	11	9	7
> 0.21	2	4	12	19
Percentage of cases negative for cocaine (%)	91	74	50	26

observed. Nonetheless, it cannot be ruled out that some of the cases negative for cocaine in the blood were positive for cocaine at death.

We conclude from these data that urine BE concentrations should be considered cautiously as they do not generally correlate with blood cocaine concentrations; thus, the quantitation of urine concentrations is not necessary when direct prediction of impairment is desired.

Karla A. Moore, Barry Levine, and David R. Fowler
Office of the Chief Medical Examiner
State of Maryland
and
Division of Forensic Pathology
University of Maryland
111 Penn Street
Baltimore, Maryland 21201

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