Evaluation of Common Urine Specimen Adulteration Indicators

To the Editor:

It may not always be easy to distinguish between an adulterated urine and a genuine one that responds marginally towards tests implemented to monitor parameters indicative of adulteration. Criteria commonly used for checking sample integrity in forensic drug urinalysis include specific gravity, pH, and creatinine level. Selecting appropriate "cutoff" values of these parameters that can be effectively used to identify presumptive positive adulteration samples for further confirmatory identification of adulterant is no trivial matter. Whether the monitoring of these parameters can provide an effective mechanism for identifying specimen adulteration has always been a question to us.

In this report, we examine creatinine content, pH, and specific gravity of 144 urine samples that are highly suspicious of adulteration based on their color, smell, sedimentation, or the abnormally low absorbance reading observed in an enzyme immunoassay test. With the exception of the absorbance reading, the parameters used to select these 144 samples, although possibly effective, are subjective observations. The main thrust of this study is to use this highly relevant sample population to evaluate the effectiveness of these commonly used (and objectively monitored) parameters—that is, specific gravity, pH, and creatinine level—for the identification of specimen adulteration.

Creatinine Content

Creatinine excretions of men and women reportedly fall in the 14–26 mg/kg and 11–20 mg/kg ranges, respectively (1). It was also reported (2) that healthy volunteers excrete creatinine in the 0.7–10.6mM and 0.6–4.8mM ranges two hours after consuming 0.5 L and 1.0 L water, respectively, and that 95% of the samples from healthy volunteers had creatinine concentrations less than 3.8mM taken during five hours after the intake of 0.5 L water. Based on this data and data obtained from 176 former heroin abusers in which five out of ten samples with creatinine less than 4.3mM were falsely negative, it was recommended (2) that a creatinine value of 4.0mM [≅ 45 mg/dL] be used as the cutoff for preliminary identification of whether a sample has been diluted (in vitro or in vivo).

With the above information in mind, we have grouped the pH and specific gravity data of the aforementioned 144 urine samples based on their creatinine content (Table I). It is apparent that pH is not an effective parameter for identifying urine samples that may have been adulterated: only six out of these 144 samples exhibit pH readings outside the 4.6–8.0 range that is considered normal for urine (3).

Specific Gravity

Specific gravity data are much more informative. Because urine with specific gravity less than 1.007 is considered low (hyposthenuric), while 1.035 is listed as the high-end limit of adult urine (3), the 1.007–1.035 range was adopted in this study as the acceptable range of urine specific gravity readings. Of the 46 samples that failed the creatinine criterion (≤ 45 mg/mL), 36 of them also exhibited specific gravity readings outside the 1.007–1.035 range. Furthermore, among the 98 samples that passed the creatinine content criterion, 29 of them failed the specific gravity criterion. Or, to evaluate these data in a different way, 79 out of the 144 highly suspicious samples exhibited specific gravity readings within the 1.007–1.035 range, among which 10 failed the creatinine content criterion (≤ 45 m/dL).

Table I. Specific Gravity and pH Distribution of Urine (Analyzed for Adulteration) at Different Ranges of Creatinine Content

Creatinine content (mg/dL)*: no. of samples	pH Range: no. of samples	Specific gravity: no. of samples
≤ 45: 46 (31.9%)†	4.6–8: 44 (95.7%)‡	1.007–1.035: 10 (21.7%)‡
	< 4.6: 1 (2.2%)	< 1.007: 35 (76.1%)
	> 8: 1 (2.2%)	> 1.035: 1 (2.2%)
>45: 98 (68.1%)†	4.6–8: 94 (95.9%)‡	1.007–1.035: 69 (70.4%)‡
	< 4.6: 1 (1.0%)	< 1.007: 25 (25.5%)
	> 8: 3 (3.1%)	> 1.035: 4 (4.1%)

* 1mM = 11.3 mg/dL; 45 mg/dL ≅ 4mM.
† Percentage is calculated based on the total number of sample population, 144.
‡ Percentage is calculated based on the number of samples with the indicated creatinine content.

In summary, combining the 1.007–1.035 specific gravity range and greater than 45 mg/dL creatinine content as urine specimen integrity criteria, 69 (47.9%) out of the 144 highly suspicious samples evade detection. If creatinine content alone is used, 98 (68.1%) samples will not be detected, while if specific gravity criterion alone is used, 79 (54.9%) samples will not be identified. If pH alone is used as the criterion, only six samples will be identified (five of these six identified also exhibit abnormal creatinine and specific gravity readings). In the final analysis, because the pH criterion only helped identify one additional sample, it can hardly be considered an effective indicator for characterizing urine specimen adulteration. While creatinine content and specific gravity determinations provide a much better identification rate, almost half (47.9%) of these highly suspicious samples still could not be identified with the combined use of these two criteria. Thus, it is apparent that other criteria, including visual inspection, are needed for effective characterization of adulterated urine samples.

Cinnamon Edwards[1,2], Mary J. Fyfe[1], Ray H. Liu [1,2,*], and A.S. Walia[1]
[1]Environmental Chemical Corporation, Birmingham, AL 35205
[2]Department of Criminal Justice, University of Alabama at Birmingham, Birmingham, AL 35294

* Author to whom correspondence should be addressed.

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