Alcohol Concentration in Urine and Its Forensic Evidence

Peter Zink and Günther Reinhardt

The first experiments regarding the relationship between alcohol concentration in blood and urine were performed by Widmark in 1930. Since then there have been many experiments performed all over the world. In the last few years, using human subjects, we have conducted research on (a) the trend of ureteral urine alcohol concentration, (b) the relationship between ureteral urine-, vesical urine- and blood alcohol, (c) the equilibrium between blood, serum and urine by constant blood alcohol concentration and (d) the permeability of the bladder for alcohol.

OBSERVATIONS

Because of physiological conditions, the urine alcohol concentration depends upon the following: (a) quantity of blood alcohol concentration, (b) amount of alcohol concentration in the ureteral urine, (c) diuresis, (d) time between the mictions, and (e) permeability of the bladder for alcohol.

We have found that the rising ureteral urine alcohol curvature follows the blood alcohol and serum alcohol curve by about 10 minutes. We obtained the result from a patient with an ileal conduit. The same results were obtained from subjects who provided urine samples every 10 minutes. A comparison between the concentration of bladder excretion and ureteral excretion gave almost identical results when bladder samples were taken at short intervals.

With longer periods between mictions, for example up to one hour, the quotient alcohol in urine to alcohol in blood was low (0.5 - 1) in the initial stages after drinking; when the maximal stage was past, a quotient of 1.3 - 1.4 was obtained. When the blood alcohol concentration fell to values less than 30 mg/100 ml the quotient could increase to more than 2. From these experiments we found that the vesical alcohol concentration compared to the blood alcohol concentration curve reflected a difference of half an hour. After drinking 2 liters of tea this period was shortened to 15 minutes.

In other experiments it has been shown by direct insertion of alcohol in the bladder (concentration 1 - 2 º/oo), that the bladder walls do not let an appreciable amount of alcohol pass through. When the concentration in the bladder was 1 º/oo

1 Institut für Rechtsmedizin, D 8520 Erlangen, Universitätsstr. 22, West-Germany.
and the blood was free of alcohol we found a diminution of the amount of alcohol in the bladder of about 10 mg in the first hour. Similar results were found by Haggard, Greenberg, Carroll and Miller (4).

Experiments on diffusion have shown that the equilibrium concentration between serum and urine was 1 : 1.07 depending on the amount of protein in the serum. The same results were obtained by direct injection of alcohol into the blood stream of a human subject so that a constant blood alcohol concentration was reached. During this time, the subject gave urine samples at short intervals. The exact details of our experiments and the data involved are available elsewhere (8, 9, 10).

DISCUSSION

The experimental relationship between urine and blood alcohol concentration can be explained by diffusion of the alcohol in the kidney without active cell performance. The change of alcohol concentration in the bladder and ureter is influenced by the periods between mictions. The longer these periods the more likely there will be differences between ureteral urine and vesical urine alcohol, in that the liquid that enters the bladder from the kidneys changes its alcohol concentration.

The concentration of vesical urine is determined by diuresis. The permeability of the human bladder for ethyl alcohol has no effect on the alcohol concentration in vesical urine, even after the urine has settled over a period of several hours in the bladder.

In the maximum stages, and in the downslope of the blood alcohol curve, the vesical urine alcohol concentration by frequent miction periods is about 1.3 - 1.4 times higher than blood alcohol concentration (2, 5, 6, 7). After the first amount of alcohol has been consumed, the vesical as well as the ureteral urine alcohol concentration is less than the blood alcohol concentration of the cubital vein blood. It must not be assumed that this is caused by dilution of the first ureteral urine containing alcohol by residual urine in the bladder. The time delay can be explained by the time it takes for the kidney cells to absorb the alcohol from the blood and give it off as urine.

Even under laboratory test conditions, the variation of the quotient urine alcohol concentration/blood alcohol concentration is very high. Under practical conditions even after two urine samples have been taken, it is impossible to determine the true blood alcohol concentration from the result of the determination of alcohol concentration in the urine samples. The statistical relationship between blood and urine alcohol concentration, as determined by Froentjes and Verburgt (3) and Bonnichsen and Aberg (1), lowers the margin of error.

The phase of the blood alcohol curve can be better determined, if a blood sample and a urine sample taken at the same time, are compared. In spite of this, it is still not reliable proof or evidence of the blood alcohol phase.

The difficulties in the evaluation of urine samples in forensic cases are that the amount of alcohol consumed, the time factor of drinking, the last miction, the residual urine in the bladder and the diuresis are unknown.

REFERENCES
