

the methods used for blood-alcohol analysis or breath sampling parameters when breath-instruments are used and breath-to-breath physiological variations in alcohol concentration. However, during the absorption of ethanol from the stomach an irregular rising phase has often been observed owing to the sudden and unpredictable opening and closing of the pyloric sphincter, a muscle that controls emptying of the stomach contents into the duodenum. This might produce a series of short bursts in absorption of alcohol into the portal blood flowing to the liver resulting in a sudden rise in the peripheral blood-alcohol concentration.

### Rate of Alcohol Elimination in Pathological Conditions

The bulk of the dose of ethanol administered is metabolized in the liver. Accordingly, liver disease such as hepatitis and cirrhosis might be expected to influence the rate of ethanol metabolism (Bode, 1978). For ethical reasons, conducting drinking experiments with hospitalized patients suffering from cirrhosis are not feasible. However, some older literature on this subject is available and the work of Jokipii (1951) deserves mention. His studies were done with male and female subjects and the patient material was well characterized clinically. They suffered from hepatitis, cirrhosis, diabetes mellitus, hyperthyroidism and dystonia (impaired functioning of the muscles). After an overnight fast, the subjects were challenged with a bolus dose of alcohol (0.50 g/kg as spirits), under the strictly controlled conditions advocated by Widmark (1932). Table 4-5 gives the mean and range of  $\beta$ -slopes for the different patient groups in comparison with a control group of healthy individuals. Test subjects with the various diseases had mean  $\beta$ -slopes within the same range as healthy control subjects except for a few low values in the patients. The lowest  $\beta$ -slope in the patient groups was 7 mg/dl/h or 0.007 g% per h. The distribution of ethanol in the body as reflected in the value of Widmark's "r" was about the same for the patient groups and the control group of healthy subjects (Jokipii, 1951).

It seems that subjects suffering from various metabolic diseases and liver cirrhosis still maintain their ability to eliminate alcohol from the bloodstream (Mezey and Tobon, 1971; Lieberman, 1961). Most of the alcohol consumed is oxidized in the liver as demonstrated in experiments with hepatectomized or eviscerated animals (Clark et al, 1941). But even with the liver removed, these animals were capable of metabolizing ethanol: in an hepatectomized dog the elimination rate was 5.5 mg/dl/h compared with 14 mg/dl/h in control animals.

Articles citing an unusually wide range of  $\beta$ -slopes and especially the existence of extremely low rates of alcohol elimination (below 8 mg/dl/h) are

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**Table 4-5**

Influence of various metabolic diseases and pathological conditions on the rate of disappearance of ethanol from the bloodstream ( $\beta$ -slope). The subjects drank 0.50 g ethanol/kg body weight as a bolus dose of spirits (30-40% v/v) after an overnight fast.

Subjects and Conditions	Mean values for men and women	
	Number of subjects	Mean $\beta$ -slope <sup>1</sup> (span)
Healthy subjects	42 (19m, 23w) <sup>2</sup>	13 (10 - 17)
Dystonia <sup>3</sup>	17 (11m, 6w)	11 (7 - 15)
Hepatitis	19 (8m, 11w)	11 (7 - 14)
Cirrhosis	6 (5m, 1w)	11 (9 - 13)
Hyperthyreosis	15 (3m, 12w)	14 (8 - 19)
Diabetes Mellitus	21 (13m, 8w)	12 (7 - 19)

<sup>1</sup>  $\beta$  = rate of disappearance of ethanol from blood in mg/dl/h.

<sup>2</sup> m = men, w = women.

<sup>3</sup> Dystonia is a disordered tonicity of muscles.

obviously not very reliable. These abnormal values are usually the result of making statistical projections from distributions with large standard deviation. This might occur, for example, when the mean and variance are calculated for a non-homogenous experimental group of subjects, e.g. by including moderate drinkers and alcoholics, or  $\beta$ -slopes for men and women, or drinking under fed and fasting conditions. Furthermore, drinking studies with an insufficient number of concentration-time points or an unusually large scatter can easily give unreliable estimates of  $\beta$ -slope. A classic example of this can be found in the paper by Winek and Murphy (1984) where a person with a  $\beta$ -value of 1 mg/dl/h was reported in a peer-review journal without comment. This abnormally low result should have been immediately suspect because in another experiment with the same individual the  $\beta$ -slope was 14 mg/dl/h. Finally the practice of calculating a person's  $\beta$ -slope by taking 2 blood samples 1-2 hours apart is not recommended. Although the rate of change in BAC over the sampling interval is obtained, this is not the most reliable indication of the person's rate of ethanol disposal (Neuteboom and Jones, 1990). This follows because the results obtained might be influenced by on-going absorption and distribution of alcohol during the sampling interval. Reliable information about the phase of alcohol metabolism cannot be ascertained from analyzing just two blood samples.