

DETERMINING THE CONCENTRATION OF ALCOHOL IN THE BODY

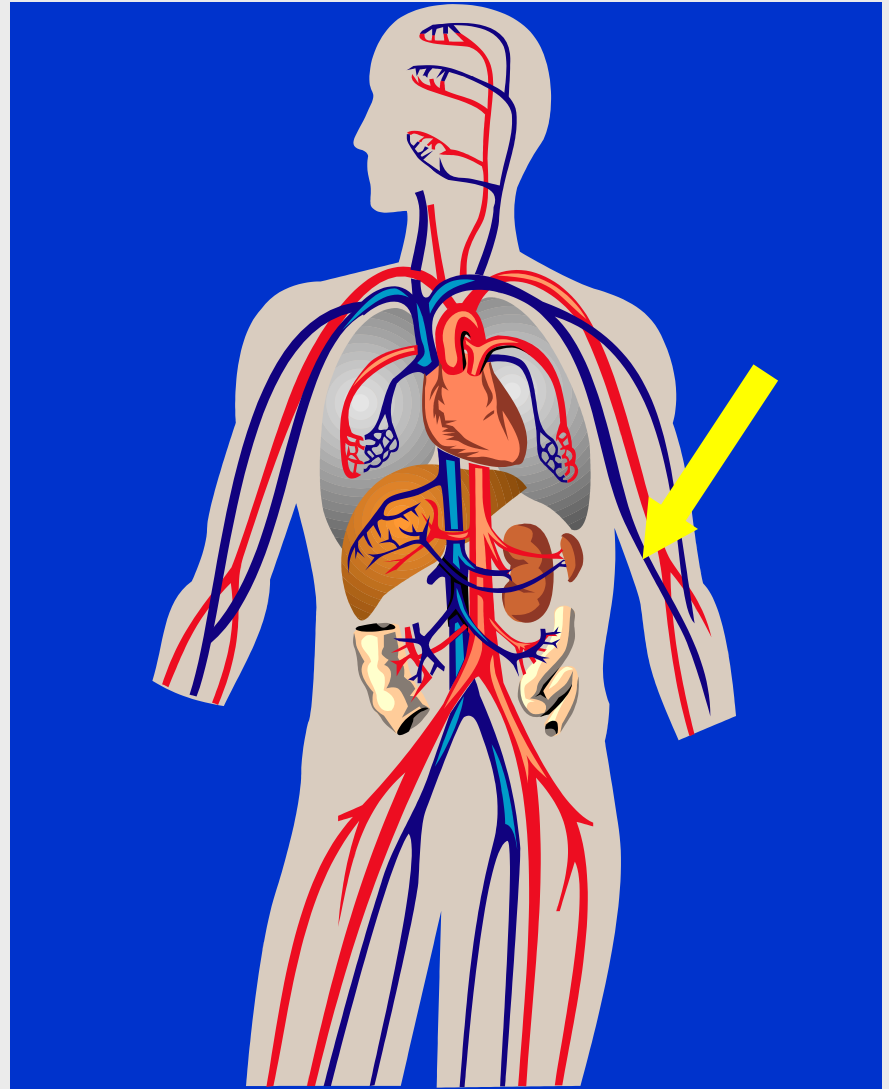
A collage of four images illustrating alcohol testing scenarios. The top-left image shows a man in a dark jacket looking at a computer screen in an office setting. The top-right image shows a police officer in a white uniform and cap holding a breathalyzer device to a woman's mouth next to a police car. The bottom-left image shows a man in a dark jacket holding a small, white, handheld device to his mouth. The bottom-right image shows a man in a dark jacket holding a cigarette to his mouth.

BLOOD ALCOHOL CONCENTRATION

The heart pumps the blood through the body.

The blood is distributed throughout the body's tissue and then flows back to the heart through the veins.

To determine the concentration of alcohol, a **sample of this venous blood** is taken from the inside of the elbow. After the necessary preparation, the blood alcohol concentration can then be determined by means of various analytical techniques.



MEASURING THE BLOOD ALCOHOL CONCENTRATION

WIDMARK FORMULA

based on the ease with which ethyl alcohol oxidizes chemically.



Historically speaking, this is the oldest method and is in widespread use worldwide.

Measurement:

a precise quantity of whole blood or serum is subjected to micro-distillation at 60°C.

The alcohol then passes into dichromate sulphuric acid, where it oxidizes. At the same time, a corresponding amount of yellow chromate is reduced to green chromate-(III).

The quantity of the non-consumed chromate is then calculated by means of iodometric titration.

MEASURING THE BLOOD ALCOHOL CONCENTRATION

ADH METHOD



The advantage of the ADH method over the Widmark technique is that ether and acetone, for example, are not included in the measurement, i.e. the method offers high specificity.

Measurement:

Alcohol is hydrogenated with the aid of the ADH enzyme (=alcohol dehydrogenase). The resulting hydrogenated product is determined by spectrophotometry at 366 nm.

MEASURING THE BLOOD ALCOHOL CONCENTRATION

GAS CHROMATOGRAPHY

Measurement:

Blood and serum are injected directly into the gas chromatograph.

Acetone is used as the inner standard.

Water is not indicated thanks to the use of a flame ionization detector (FID).

The quantitative analysis is conducted by automatic integration.

ESTIMATING THE BLOOD ALCOHOL CONCENTRATION

WIDMARK FORMULA

(Error range +/- 20 %):

- C: Blood alcohol concentration in ‰ which can be expected after time t (in hours).
- A: Consumed alcohol quantity in g
- W: Body weight in kg
- r: Reduction factor (0.5 - 0.8; men approx. 0.7; women approx. 0.6)
- β: Hourly breakdown of alcohol (0.14 - 0.22 ‰)
- t: Period of time (in hours) between maximum blood alcohol concentration (approx. 1-1.5 hours after end of drinking) and blood sample.

$$C (\text{‰})$$
$$=$$

$$\frac{A(\text{g})}{W(\text{kg}) * r - \beta * t(\text{h})}$$

Using this formula, the blood alcohol concentration at the time of the accident can be calculated.

ESTIMATING THE BLOOD ALCOHOL CONCENTRATION

WIDMARK FORMULA

To estimate the blood alcohol concentration, the following simplified Widmark calculation is often used.

- C: Blood alcohol concentration in ‰ which can be expected after time t (in hours).
- A: Consumed alcohol quantity in g
- W: Body weight in kg
- r: Reduction factor (0.5 - 0.8; men approx. 0.7; women approx. 0.6)

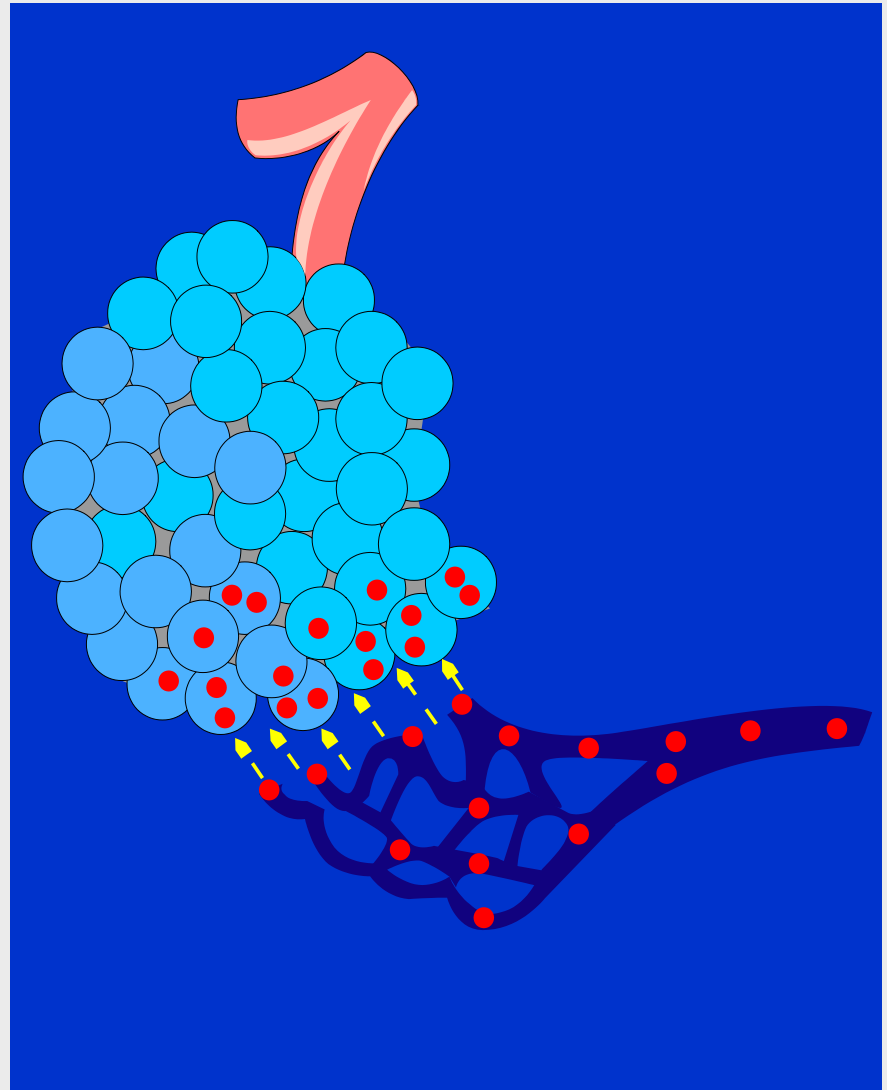
Simplified Widmark calculation:

$$C (\text{‰}) = \frac{A(\text{g})}{W (\text{kg}) * r}$$

BREATH ALCOHOL CONCENTRATION

A **fixed equilibrium** is generated between the alcohol concentration in the blood in the lungs (BAC) and the alcohol concentration in the air in the lungs (BrAC) as a result of diffusion compensation processes in accordance with *Henry's law*.

This concentration is determined **directly** during breath alcohol measurement.



DETERMINING THE BREATH ALCOHOL CONCENTRATION (BrAC)

The breath alcohol concentration (BrAC) is the concentration of ethanol (mass concentration in an **end-expiratory sample**) obtained from oral exhalation.

The breath alcohol concentration is stated in [mg/l] (= mg ethanol per litre of exhaled air, at 34° C and 1013 mbar).

Under ideal conditions (elimination phase, constant temperature), the **alcohol concentration of the alveolar air** in the lungs (measured in mg/l) will be on average by a factor of **2100** below the **blood alcohol concentration** (measured in g/l).

BREATH ALCOHOL CONCENTRATION

UNITS OF MEASUREMENT

Breath alcohol concentration (BrAC)

= *gas concentration*

Milligrams of ethanol per litre of exhaled air (mg/l) at a temperature of 34° C and 1013 mbar.

Blood alcohol concentration (BAC)

= *liquid concentration*

Per mille (‰); refers to the amount of ethanol in grams per litre of blood.

Measurement of an end-expiratory sample of air (deep lung air) is needed to ensure an accurate measurement of the BrAC.

Comment: