Physiological Effects of Alcohol, and Blood Alcohol Concentration (BAC)

Units of measurement

There are several different units in use around the world for defining blood alcohol concentration. Each is defined as either a mass of alcohol per volume of blood or a mass of alcohol per mass of blood (never a volume per volume). 1 milliliter of blood is approximately equivalent to 1 gram of blood, 1.06 grams to be exact. Because of this, units by volume are similar but not identical to units by mass.

Unit	Dimensions	Equivalent to	Used in
1 percent BAC by volume	1/100 (%) g/mL = 1 cg/mL	9.43 mg/g, 217.4 mmol/L	United States, Australia, Canada

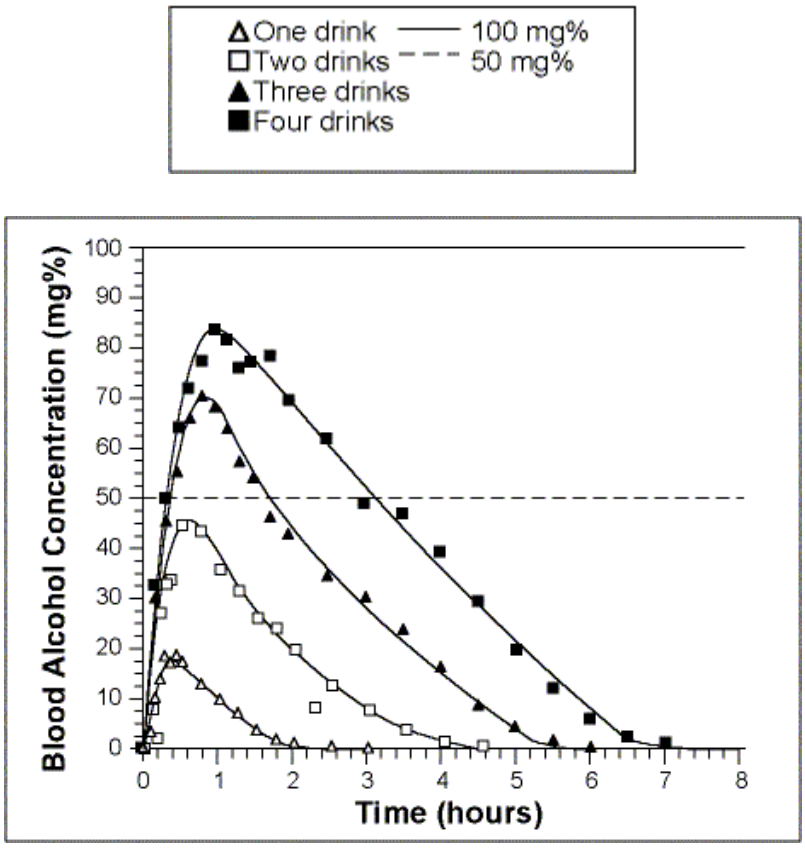
Alcohol Metabolism

(Alcohol Alert From NIAAA)

This *Alcohol Alert* explains, by understanding alcohol metabolism, we can learn how the body can dispose of alcohol and discern some of the factors that influence this process. Studying alcohol metabolism also can help us to understand how this process influences the metabolism of food, hormones, and medications.

Metabolism is the body's process of converting ingested substances to other compounds. Metabolism results in some substances becoming more, and some less, toxic than those originally ingested. Metabolism involves a number of processes, one of which is referred to as oxidation.

Through oxidation, alcohol is detoxified and removed from the blood, preventing the alcohol from accumulating and destroying cells and organs. A minute amount of alcohol escapes metabolism and is excreted unchanged in the breath and in urine. Until all the alcohol consumed has been metabolized, it is distributed throughout the body, affecting the brain and other tissues (1,2).



Blood alcohol concentration (BAC) after the rapid consumption of different amounts of alcohol by eight adult fasting male subjects.* (Adapted from Wilkinson et al., *Journal of Pharmacokinetics and Biopharmaceutics*5(3):207-224, 1977.)

100 mg% is the legal level of intoxication in most States. 50 mg% is the level at which deterioration of driving skills begins. *(JAMA* 255:522-527, 1986.)

**If the same number of drinks are consumed over a longer period of time, BAC's will be lower.*

The Metabolic Process

When alcohol is consumed, it passes from the stomach and intestines into the blood, a process referred to as absorption. Alcohol is then metabolized by enzymes, which are body chemicals that break down other chemicals. In the liver, an enzyme called alcohol dehydrogenase (ADH) mediates the conversion of alcohol to acetaldehyde. Acetaldehyde is rapidly converted to acetate by other enzymes and is eventually metabolized to carbon dioxide and water. Alcohol also is metabolized in the liver by the enzyme cytochrome P450IIE1 (CYP2E1), which may be increased after chronic drinking (3). Most of the alcohol consumed is metabolized in the liver, but the small quantity that remains unmetabolized permits alcohol concentration to be measured in breath and urine.

The liver can metabolize only a certain amount of alcohol per hour, regardless of the amount that has been consumed. The rate of alcohol metabolism depends, in part, on the amount of metabolizing enzymes in the liver, which varies among individuals and appears to have genetic determinants (1,4). In general, after the consumption of one standard drink, the amount of alcohol in the drinker's blood (blood alcohol concentration, or BAC) peaks within 30 to 45 minutes. (A standard drink is defined as 12 ounces of beer, 5 ounces of wine, or 1.5 ounces of 80-proof distilled spirits, all of which contain the same amount of alcohol.) The BAC curve, shown on the previous page, provides an estimate of the time needed to absorb and metabolize different amounts of alcohol (5). Alcohol is metabolized more slowly than it is absorbed. Since the metabolism of alcohol is slow, consumption needs to be controlled to prevent accumulation in the body and intoxication.

Factors Influencing Alcohol Absorption and Metabolism

Food. A number of factors influence the absorption process, including the presence of food and the type of food in the gastrointestinal tract when alcohol is consumed (2,6). The rate at which alcohol is absorbed depends on how quickly the stomach empties its contents into the intestine. The higher the dietary fat content, the more time this emptying will require and the longer the process of absorption will take. One study found that subjects who drank alcohol after a meal that included fat, protein, and carbohydrates absorbed the alcohol about three times more slowly than when they consumed alcohol on an empty stomach (7).

Gender. Women absorb and metabolize alcohol differently from men. They have higher BAC's after consuming the same amount of alcohol as men and are more susceptible to alcoholic liver disease, heart muscle damage (8), and brain damage (9). The difference in BAC's between women and men has been attributed to women's smaller amount of body water, likened to dropping the same amount of alcohol into a smaller pail of water (10). An additional factor contributing to the difference in BAC's may be that women have lower activity of the alcohol metabolizing enzyme ADH in the stomach, causing a larger proportion of the ingested alcohol to reach the blood. The combination of these factors may render women more vulnerable than men to alcohol-induced liver and heart damage (11-16).

Online BAC Calculator:

http://www.dot.wisconsin.gov/safety/motorist/drunkdriving/calculator.htm

Buy your own Breathalyzer – fairly cheap:

http://www.amazon.com/Breathalyzer-Personal-Digital-Detector-Analyzer/dp/B000AM0G7A/ref=sr_1_sc_2?ie=UTF8&qid=1265564500&sr=1-2-spell

Laws (**http://en.wikipedia.org/wiki/Drunk_driving_in_the_United_States**)

All states in the U.S. designate a *per se* blood or breath alcohol level as the threshold point for an independent criminal offense. A second criminal offense of driving "under the influence" or "while impaired" is also usually charged in most states, with a permissive presumption of guilt where the person's blood alcohol concentration (BAC) is .08 percent or greater (units of milligrams per deciliter, representing 8 g of alcohol in 10 liters of blood).[1] Some states (e.g., Colorado) include a lesser charge, sometimes referred to as **driving while ability impaired** (this may apply to individuals with a .05 percent or above, but less than the .08 per se limit for the more serious charge.[1] Wisconsin, however, is the only state that continues to regard first offense drunk driving arrests as a forfeiture.[2]

The amount of alcohol intake to reach 0.08 percent may vary with the individual's body composition and state of health

Prior to increased emphasis on drinking and driving in the 1980s, standards of .10-.15 percent were in place. The legal limit for commercial drivers in New York is set at 0.04 percent.[1]

[1]See, *e.g.*, New York Penal Law section 1192, found at New York State Assembly web site, go to "Bill Search and Legislative Materials", then "New York State Laws." Accessed April 2, 2008.

[2]Appel J (2009). "Must physicians report impaired driving? Rethinking a duty on a collision course with itself". *The Journal of Clinical Ethics* **20** (2): 136–40. PMID 19554818

BAC Chart for Men

Men									
	Approximate Blood Alcohol Percentage								
Drinks	**Body Weight in Pounds**								
	100	120	140	160	180	200	220	240	
0	.00	.00	.00	.00	.00	.00	.00	.00	Only Safe Driving Limit
0	.00	.00	.00	.00	.00	.00	.00	.00	Only Safe Driving Limit
1	.04	.03	.03	.02	.02	.02	.02	.02	Driving Skills Significantly Affected
2	.08	.06	.05	.05	.04	.04	.03	.03	
3	.11	.09	.08	.07	.06	.06	.05	.05	
4	.15	.12	.11	.09	.08	.08	.07	.06	
5	.19	.16	.13	.12	.11	.09	.09	.08	Possible Criminal Penalties
6	.23	.19	.16	.14	.13	.11	.10	.09	Legally Intoxicated
7	.26	.22	.19	.16	.15	.13	.12	.11	
8	**.30**	.25	.21	.19	.17	.15	.14	.13	Criminal Penalties
9	**.34**	.28	.24	.21	.19	.17	.15	.14	
10	**.38**	**.31**	**.27**	.23	.21	.19	.17	.16	**Death Possible**
Subtract .01% for each 40 minutes of drinking. One drink is 1.25 oz. of 80 proof liquor, 12 oz. of beer, or 5 oz. of table wine.									

BAC Chart for Women

Women										
	Approximate Blood Alcohol Percentage									
Drinks	**Body Weight in Pounds**									
	90	100	120	140	160	180	200	220	240	
0	.00	.00	.00	.00	.00	.00	.00	.00	.00	Only Safe Driving Limit
0	.00	.00	.00	.00	.00	.00	.00	.00	.00	Only Safe Driving Limit
1	.05	.05	.04	.03	.03	.03	.02	.02	.02	Driving Skills Significantly Affected
2	**.10**	**.09**	**.08**	.07	.06	.05	.05	.04	.04	
3	**.15**	**.14**	**.11**	**.10**	**.09**	**.08**	.07	.06	.06	
4	**.20**	**.18**	**.15**	**.13**	**.11**	**.10**	**.09**	**.08**	**.08**	Possible Criminal Penalties
5	**.25**	**.23**	**.19**	**.16**	**.14**	**.13**	**.11**	**.10**	**.09**	
6	**.30**	**.27**	**.23**	**.19**	**.17**	**.15**	**.14**	**.12**	**.11**	Legally Intoxicated
7	**.35**	**.32**	**.27**	**.23**	**.20**	**.18**	**.16**	**.14**	**.13**	
8	**.40**	**.36**	**.30**	**.26**	**.23**	**.20**	**.18**	**.17**	**.15**	Criminal Penalties
9	**.45**	**.41**	**.34**	**.29**	**.26**	**.23**	**.20**	**.19**	**.17**	
10	**.51**	**.45**	**.38**	**.32**	**.28**	**.25**	**.23**	**.21**	**.19**	**Death Possible**
Subtract .01% for each 40 minutes of drinking. One drink is 1.25 oz. of 80 proof liquor, 12 oz. of beer, or 5 oz. of table wine.										

This information is taken from Virginia Tech Alcohol Abuse Prevention website.