Physiological Effects of Alcohol

*This newsletter is the first of a two-part series on the “physiological effects of alcohol.” Part two, “chronic effects” will appear in the spring issue of Higher Education.

Today, approximately two-thirds of the adult population in the United States drinks alcoholic beverages, yet few consumers really understand alcohol’s actions on the body.

The active ingredient in beer, wine, and spirits, known simply as “alcohol” is ethyl alcohol or ethanol, a small organic, water-soluble molecule with the chemical formula CH₃CH₂OH. Alcohol is produced naturally by yeasts in the process of fermentation and produced synthetically for industrial and commercial uses. Beers and wines are direct products of grain and fruit fermentation, respectively. Distillation of fermented mash, a mixture of grains, water, sugar, and yeast, produces liquors and liqueurs or spirits.

**PART 1: ACUTE EFFECTS**

**CONCENTRATION OF ALCOHOL IN THE BLOOD**

Basically, the effects alcohol will have on a person depend upon how much alcohol builds up in the bloodstream. The blood alcohol concentration (BAC) and how quickly the concentration rises and falls depend on how much alcohol is consumed, how fast it is absorbed from the stomach and small intestine into the blood, how it is distributed in the body and then how quickly it is eliminated from the body.

How much alcohol does someone ingest when he or she takes “a drink”? A 12 oz. can of beer, a 5 oz. glass of wine and a shot of whiskey all contain approximately the same amount of alcohol, about .06 ounces. People often think that if they drink beer or wine instead of “hard liquor” they are consuming less alcohol. That’s a mistaken idea. The alcohol is less concentrated in beer and wine than in spirits, but a typical serving of each contains about the same amount of alcohol.

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<th>One Drink Equals</th>
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<td>12 oz. beer = 4-5 oz. wine = 1 oz. whiskey</td>
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So, in terms of alcohol’s effects on the mind and body, choosing between wine, beer, or hard liquor is irrelevant—the actual amount of alcohol consumed is the important consideration.

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HOW THE BODY ABSORBS ALCOHOL

The type of alcoholic drink can have a direct effect on the absorption of ethanol. In mixed drinks, the "mixer" dilutes the liquor. The amount of mixer in a drink influences the rate at which alcohol is absorbed into the blood---an important factor in determining the concentration in the blood.

The more diluted the drink, the slower the gastrointestinal tract absorbs the alcohol. The absorption rate is also affected by the speed with which alcohol reaches the small intestine. Alcohol essentially bypasses the stomach because it does not require digestion. It is absorbed along the entire length of the GI tract, but primarily by the first sections of the small intestine. As much as 80 percent of what is drunk is absorbed in the small intestine. Anything that causes alcohol to remain in the stomach longer will slow absorption. Thus, both the amount and type of mixer influence absorption. A concentrated drink irritates the lining of the digestive tract, may paralyze the musculature of the stomach wall and cause the valve between the stomach and small intestine to spasm, thus delaying passage of the alcohol into the small intestine. The sugar in a sweet mixer will also slow absorption, but for other reasons. A carbonated mixer, on the other hand, will speed the passage of alcohol into the small intestine (ex. rum and coke).

Food eaten just before or during drinking slows absorption of alcohol, especially if the foods are high in oils or milk products. A heavy meal may slow absorption to the point that the peak BAC is not reached for as long as six hours. Slower absorption means that the peak concentration should be lower. Food also stimulates secretions such as gastric acid which dilutes the alcohol and slows its absorption.

HOW THE BODY ELIMINATES ALCOHOL

Almost as soon as alcohol enters the blood, the body begins trying to eliminate it. One to three percent of the alcohol is given off unchanged in the urine, perspiration and expired air from the lungs; during exercise the percentage eliminated will increase, but does not go beyond five percent. The remainder of the alcohol in the blood is oxidized or "burned up" mostly by the liver. The liver is a complex organ with the important function of detoxifying poisonous substances that enter the body; about 80 percent of the oxidation of alcohol takes place within the liver. How does alcohol accumulate in the blood if it is being eliminated even as it is still being absorbed from the GI tract? If the rate at which alcohol is being absorbed exceeds the rate at which it is eliminated, the concentration of alcohol in the blood has to go up.

The rate at which metabolism of alcohol occurs is somewhat variable. It is affected by such things as age, time of day, racial extraction, health of the liver, drugs, food, menstrual cycle, and oral contraceptives. It has been shown that just before menstruation women have a slower rate of alcohol metabolism and that taking oral contraceptives lowers the rate at which women eliminate alcohol.

THE EFFECTS OF ALCOHOL ON DIGESTION

Although most effects occur after alcohol enters the bloodstream, the lining of the gastrointestinal (GI) tract responds to alcohol. Low concentrations of alcohol have the direct effect of stimulating secretion of gastric (stomach) juices, which is why a glass of wine before a meal is reputed to stimulate the appetite; but higher concentrations inhibit the digestive enzymes and irritate the gastric lining.
HOW THE BODY DISTRIBUTES THE ALCOHOL

As blood courses throughout the body, alcohol easily diffuses into cells via the cell membranes. Organs having a dense network of blood vessels and a constant rich blood supply—the brain, kidneys, liver, and lungs—quickly attain the same alcohol level as the blood. These organs get higher initial concentrations of alcohol than other organs, especially if the person is at rest while drinking.

Eventually, the alcohol in the blood becomes distributed at equal concentration throughout the water in all the tissues of the entire body, including the blood. At this saturation point the BAC is at its maximum. Unless the person drinks more alcohol, the BAC will begin to decrease at an even rate.

How high the BAC rises, and therefore how intoxicated the drinker becomes, depends on the rates of absorption and elimination and on the distribution of alcohol in the body. There are surprising differences in the water content of various types of body tissues, which helps account for a significant difference in intoxication between men and women. Adipose or fatty tissue contains less water than muscle tissue. Because women generally carry more adipose tissue than men, and because alcohol tends to dissolve in the water of tissues, a given amount of alcohol will remain more concentrated in the fluids of a woman’s body than in a man’s of the same weight, thus giving her a higher maximum BAC. This fact, together with the effects of menstruation and oral contraceptives on women’s alcohol metabolism, produces the difference. Body weight can affect alcohol distribution and the concentration. A 210-pound man has considerably more body water than does a 140-pound man; the water in the tissues dilutes the alcohol, so the same amount of alcohol will affect the blood alcohol concentration differently.

HOW THE HEART AND CIRCULATORY SYSTEMS RESPOND

Low to moderate doses of alcohol will produce a slight and fleeting increase in heart rate and blood pressure. At higher concentrations, alcohol can reduce the heart’s pumping power and produce irregular electrocardiograms. Brief drinking sprees by apparently healthy individuals can produce rhythmic disturbances in the heartbeat. Also, at low to moderate doses, the blood vessels within the muscles constrict, but those vessels at the surface of the skin dilate, producing rapid heat loss from the skin—sometimes apparent as a flushing or reddening of the skin. Large doses of alcohol decrease body temperature and impair its ability to regulate heat.

HOW THE ENDOCRINE SYSTEM REACTS

The endocrine system is a series of glands that regulate the physiology of the body by producing and secreting hormones. Several of alcohol’s immediate actions involve this system. The pancreas plays a dual role: it contributes to digestion, and it functions as part of the endocrine system by secreting insulin, a hormone that reduces the level of sugar in the blood. Normally, carbohydrates quickly raise the level of blood sugar (glucose), and the pancreas responds to the surge by secreting enough insulin to keep this level in a normal range. However, in the presence of alcohol, the pancreas seems to overreact, producing abnormally high levels of insulin, and the result can be temporary hypoglycemia (low blood sugar).

Another endocrine effect of alcohol consumption is its promotion of diuresis, or increased urination. The increase in urination occurs only while the BAC is rising.
HOW THE NERVOUS SYSTEM REACTS

Probably the best known and most easily recognized effects of alcohol intoxication involve the central nervous system. As the blood alcohol concentration becomes higher, the depressant action of alcohol progressively involves more functions of the brain. At a blood alcohol concentration of 0.08, which is the legal limit in most states, the voluntary motor skills have become perceptibly impaired. Also around this level, a person takes longer than usual to react to visual or auditory stimulus.

HOW ALCOHOL INTERACTS WITH OTHER DRUGS

If alcohol by itself produces a complex set of physiological changes, what happens if it is taken in combination with other drugs? The interaction of other drugs with alcohol is classified as either antagonistic, additive, or supra-additive. In an antagonistic interaction, the effectiveness of one or both is diminished. For example, alcohol could cause a prescribed medication to be partially or totally ineffective. If a drug interacts additively with alcohol, for example, alcohol plus antihistamines, any effects that are similar between the two are proportionally intensified above the level that either drug could produce alone. Supra-additive interactions produce effects that are significantly greater than the combined effects of both drugs. Figuratively speaking, two plus two may equal five or ten.

TAKING ANY ILLEGAL OR ILLICIT DRUG WHILE DRINKING ALCOHOL COULD BE DANGEROUS OR FATAL.

WHAT'S A HANGOVER?

It is ironic that little is understood about the physiological effects and mechanisms that are responsible for the well-known aftermath of drinking alcohol---the hangover. It is possible that chemicals present in alcohol may play a significant role in producing hangovers. Low blood sugar that follows drinking has also been implicated as a hangover cause.