

PHYSIOLOGY OF ALCOHOL.

A wide variety of alcoholic drinks are consumed as a relaxant or to promote companion ship. Often it is consumed for other reasons as well. The active component of all these beverages is ^{ethyl} acetyl alcohol. The aim of this talk is to indicate the changes brought about by this substance in the human body.

Absorption, metabolism and elimination:

When alcohol is consumed, absorption starts in the stomach but the most is absorbed in the small intestine. It injures the gastric mucosa. This aids diffusion of acid through the barriers of the stomach. The mucosa of females is less resistant than males (alcohol dehydrogenase). These effects may cause gastric ulcer in susceptible individuals and worsen any gastric ulcer already present. Some people may vomit blood because of erosion and bleeding in to stomach.

All absorbed alcohol enters the blood and circulates all over the body. The blood level of alcohol increases rapidly after consumption and reduces slowly as it is removed by the liver. The blood level of alcohol depends on the volume of body fluids and the amount consumed. Females, because they have smaller body mass and larger proportion of fat (25%) when compared to males (15%), will have higher levels of alcohol in blood than males after consuming the same amount of alcohol.

The liver has an enzyme, alcohol dehydrogenase, which converts it into acetaldehyde which in turn is metabolized either into carbon dioxide and water or synthesized into fat. This conversion is slow. The fastest rate of conversion is about 10 to 15 ml per hour. No other tissue in the body can metabolize alcohol to any significant amount and remove it from the blood. The fat synthesized by the liver may be transported by the blood and metabolized in other tissues. A good proportion of the synthesized fat is stored in adipose tissue leading to over weight and obesity. Alcohol, therefore, even though it has a lot of energy and easily absorbed, it cannot provide easy energy for any activity. It is worth noting that glucose, which was fermented to get alcohol, can be absorbed quickly and provides quick energy to each and every tissue of the body when needed.

Some alcohol vaporises in the lung and goes out with expiratory air but the amount is negligible. The alcohol that vaporises can be

easily smelt by the people around. Since the concentration of alcohol in the expiratory air is proportional to the blood level, a 'breath test' is performed by the police in western countries to diagnose drunkenness.

Action on nervous system.

Alcohol has a wide variety of actions in the nervous system. It affects motor, sensory, and mental functions. The action is similar to that of anesthetic drugs. It is a depressor of the nervous system and not a stimulant. The alcohol appears to be a stimulant because it causes disinhibition, as anaesthetic drugs do, which will be described later.

Effects on motor functions.

Muscular contraction is the basis of any movement in the body. The muscles of the body have contractile elements and they contract when stimulated by the brain through their respective nerves. In other words, the brain has to command each muscle with regard to initiation of the movement, the degree of the force exerted and the end of contraction. The movements we see as effortless actions such as picking up a pen, writing a letter, throwing a ball, running or even walking involve many muscles and joints. If all these muscles do not contract in a coordinated fashion, with appropriate speed, force and timing, the movement will be a failure.

The first step in any action is getting the idea. The idea is then fed to the basal ganglia and the sequence of movements are planned out. The visual, auditory, equilibrium, tactile, position and other senses and past experience are utilised in the planning process. The sequence of the events is fed to the motor cortex and the cerebellum. Then the motor cortex initiates action. Once the action is initiated, the changing situation is monitored through all sensory processes mentioned above and the cerebellum becomes the centre responsible for continued, co-ordinated and smooth movement up to the expected point.

One important area that is inhibited by alcohol is the cerebellum. When a person performs muscular activity after consumption of alcohol, deficiency of cerebellar function will be exhibited in many ways. Inability to walk on a straight line, to stand still, to light a cigarette, slurred speech, double vision, are some examples. These are

familiar signs which manifest after consumption of considerable amount of alcohol. Carefully conducted experiments, especially on drivers, has shown defects in muscular activity even in small doses of alcohol. This may surprise many because we see quite a number of people moving apparently unaffected after consumption of alcohol. This is because the sequence of events of actions performed daily have been stored in the brain and can be executed without new planning. Even a slight alteration from the routine will exhibit the defect. Another factor is that the person can "hold his nerves" for some time when he knows that he is being watched.

Effects on sensory function.

Sensory function is essential for interaction with environment, other individuals and for protection. The sensations include vision, hearing, smell, taste, touch, pain and temperature. Changes in the environment stimulate the appropriate receptors. The impulses transmitted in the respective nerves are interpreted as the sensation in the brain. Alcohol inhibits all sensory receptors and also processing of the impulses in the brain.

At the receptor:

Alcohol reduces the visual acuity: that is the sharpness of the image. Also it reduces the hearing ability: only louder sounds are heard. The double vision experienced under the influence of alcohol is the result of incoordination of eye muscles due to cerebellar inhibition. The result of these become evident in a driver of a vehicle. It explains partly the association of alcohol and road traffic accidents.

Loss of smell is not usually appreciated: at occasions it had prevented detection of smell of smoke and had caused serious fire injuries in the past. Loss of taste sensation makes the food tasteless and causes trouble over the meal. The taste of "hot" is not a real taste but it is stimulation of pain fibres in the mouth. This also is inhibited and it leads to the demand for "very hot" curries.

The risks of loosing pain sensation is more harmful than we think. Nobody likes to feel pain. So, whenever there is pain, consumption of alcohol can make you feel better. But what caused the pain? Some illness. If so, it is better to treat the cause than the symptom which

is similar to swallowing aspirin or panadol. This is one of the reasons why alcohol is regarded to have medicinal properties.

Another danger of loss of pain is protection from injurious agents in the surroundings. For example, when somebody walks along, if a thorn pricks the legs, the leg is pulled up before the thorn goes deep into the leg and before the person knows about it the thorn is picked by one of the hands out of the leg. This happens through a protective withdrawal reflex initiated by pain. If that person had consumed alcohol, and pain sensation was suppressed, he would walk home without knowing that the thorn has gone deep and will become aware of it only when a serious infection has occurred. When people lose cutaneous sensation due to alcohol or disease, they are liable to all sorts of injuries.

Central mechanism:

All sensations are transmitted to the brain where they are sorted and sent to conscious mind depending on the situation. In other words, there is central processing of sensory information. This also could be inhibited by alcohol which may lead to sensory inattention. In other words, the person fails to realise the significance of the sensation he has felt. This also can lead to various accidents.

Higher functions of the brain.

Higher functions of brain involve in the control of behaviour and mental functions. The parts of brain that are responsible for these functions have not been identified conclusively. However, researchers have identified defects in higher functions when investigating drivers who can cause serious damage to them and others most by the effects of alcohol.

Alcohol reduces anxiety. Anxiety is a normal emotion which in moderate degree can be helpful force by increasing effort and alertness. When it occurs, the sympathetic system is activated and the body and mind are put in a state of readiness. Excess anxiety impairs effectiveness and is a handicap. For over anxious people alcohol may appear to do good by reducing excitement and permitting performance without worry about the standards or quality. This may be the reason for the association of alcohol with people who perform in front of an audience.

Another effect of alcohol is disinhibition. Babies respond to emotions without any second thought: the baby kicks the mother with legs; makes a big noise; or urinates in front of everybody. Can we, the grown ups, do all that the baby does? As we grow, we learn social behaviour and about rights and wrongs. These are stored in some part of the brain and are active. Every time, it is checked and our response differ depending on whether it is the boss or the servant; when the bladder is full we seek a toilet. When we see a member of opposite sex, we react in terms of some relationship as we have learnt to behave. These learnt behaviours are the result of checking within the brain which some times is regarded as inhibitions. This intellectual inhibitory function is lost under the influence of alcohol and so is the response to expression of moods. With slightest mistake, the person starts crying or blaming somebody without any consideration to the situation. If a stone is available it will be thrown and if a knife is available it will be used when provoked without any second thought. When a male under alcohol sees a female his natural sexual urge gets expression and consideration as teacher, sister, or friend - the learned relationships will not operate. These are the reasons for the association of alcohol with crime and rape. This is how alcohol becomes a stimulant: it inhibits the inhibitions.

Ability to maintain concentration on something requires training. This also is lost under alcohol. When the person is doing some thing, another thing distracts, the person will forget the fist task and go to the second. For example a driver has to maintain his attention on the road ahead in spite of distraction from within and out of the car. What will happen if he forgets the road and looks at an attractive poster or person while the car is moving?

Another important function of the brain is to work on all input of information and be able to judge the space and time. For example, a driver should be able to assess the width of the gate and decide whether the vehicle could go through it; or, he will have to judge the speed of the approaching vehicle and decide whether to wait or to take the turn. Experienced drivers with good certificates have failed after consumption of alcohol in carefully conducted studies.

Also drivers have shown delay to recover from visual or auditory dazzle. The reaction time is increased. So, if a person has to

respond to a stimulus fast, when a drunk driver sees a child in front of the vehicle and has to apply break, the reaction time, the time interval between the stimulus and completion of the task, will be prolonged because of the inhibitory effect of alcohol.

When it comes to self assessment, people under alcohol overestimate their potential, refuse to accept when they make mistakes and put the blame on others and are very confident about themselves. Some times they consider themselves to be special, gifted by god. All these give them a state of euphoria.

Dependence and tolerance.

The tissues of the body have a tendency to maintain their normal status and to resist influence of injurious agents. Such mechanism operates in the brain also. When alcohol acts on brain, certain changes occur in the brain to resist the effects of alcohol. So the brain alters itself to function in the usual way when alcohol is present. Later, when the alcohol is removed, the brain takes some time to come back to the original state. This is suggested as the main reason for the hangover after a bout of drinking. Other factors such as loss of sleep, remorse or feeling of guilt, and dehydration also contribute to this. After what appeared an enjoyable time this comes as distressing punishment. An easy way out of the hangover is to consume alcohol again and this is one reason for drinking daily.

This change in brain to single bout of drinking can usually be reversed. There is individual variation in the liability to become dependant on alcohol. Some people have a genetic predisposition and become addict soon. Any one may be affected more permanently if the drinking continues and there will be a time when the person could not exist without alcohol because of withdrawal symptoms. These may be serious with anxiety, tremors, restlessness, agitation, insomnia, irritability, sweating, nausea, exaggerated reflexes, tachycardia, delusions, hallucinations and even death. But nowadays treatment is available and people can give up drinking if they want to.

For the same reason of resisting the effects of alcohol, the functions of the brain will not be altered with the amount of alcohol consumed previously. The euphoria and feeling of confidence that the drinker seeks can be obtained only with higher doses. This is why the

amount alcohol taken goes on increasing as days go by. This is known as tolerance.

Conclusion of the effects on nervous system.

The effects of alcohol are similar to those of anaesthetic drugs. It is not a stimulant but a depressant. The difference is that the anaesthetic drugs take the person through the states mentioned above to unconscious state quickly. Alcohol has to reach high levels to bring about unconscious state. This makes it possible for a person to walk about with half consciousness. This state of over confidence with actual impaired sensory, motor and mental functions can be dangerous to that person and others.

Action on sexual function.

Effects of alcohol on sexual performance is the result of the actions already described. This topic needs a special mention because it is a fundamental act like eating: the desire for sex has to be satisfied. According to cinema and advertisements, alcohol promotes it. But Willlliam Shakespeare wrote, "alcohol provokes the desire but it takes away the performance". Every time a man sees a woman or otherwise, the natural instinct is that of sexual attraction. But our learnt behaviour converts it into friendly, sisterly or brotherly feeling depending on the situation. When this is inhibited by alcohol, the natural instinct gets expression and leads to sexual activity which may end in rape. Sometimes husbands have "raped" their own wives. This is only the beginning. Once the sexual act begins, sensory and motor functions become necessary for satisfactory sexual experience. These are impaired under the influence of alcohol. Further, regard for the other partners feelings and comfort are neglected and it ends as a failure. This is like placing a plate of good food in front of a hungry person and spoiling it when he starts eating it. This unfulfilled sexual urge manifests in many ways: search for new sexual partners or aches and pains all over that no doctor can diagnose because nobody talks of the fundamental problems. Usual end of this is broken homes and neglected children.

Effects on urinary output.

Urine is produced by filtration of plasma into the renal tubules, absorption of necessary nutrients and water. The remainder goes out as

urine. The absorption of water is under the control of Anti Diuretic Hormone which is secreted by the posterior pituitary in response to the status of body water. Alcohol inhibits secretion of ADH resulting in loss of large amounts of water in urine. So, after alcohol consumption, a person will pass a lot of urine and be happy that his kidneys are flushed but he will be dangerously dehydrated if he does not consume sufficient water. So it is easy and safer to flush the kidneys by drinking fresh water.

Action on cardiovascular system.

The immediate effects of alcohol on the heart and circulation are unpredictable. The blood pressure reduces in some and increases in others. Irregular heart beats may occur. The mechanisms of these effects are not known. But the depressant effect of the alcohol on the vasomotor centre in the brain stem and vasodilation of the skin is known. This is the reason for the feeling of warmth after consumption of alcohol. The body temperature is 37°C and the fat under the skin prevent heat loss and the skin temperature is usually lower than body temperature depending on the loss of heat to the environment. When heat production is increased as during exercise, the skin blood vessels dilate, more blood flows to the surface and heat is lost. When the vessels dilate due to alcohol and heat loss is increased without increased heat production, the body temperature may go down to dangerous level while the person feels warm and feels happy because of euphoria.

Action on respiratory system.

Alcohol dilates the respiratory passages and reduces airway resistance. It may have some beneficial effects in asthmatic patients. But now many safe and cheap drugs are available. Alcohol cannot be regarded as a treatment for asthma because it causes irregular breathing at lower concentrations by interfering the respiratory centre which is responsible for maintaining respiration and at high doses it causes respiratory depression. So far nobody seems to have died of respiratory depression because of two other actions of alcohol. It stimulates vomiting and prevents very high levels in blood. It inhibits or impairs cough reflex and swallowing reflex. Combination of these actions is dangerous because the person vomits and a portion of vomit enters the airway and gets drowned in his/her own vomit.

Action on Metabolism:

Alcohol in tissues reduces glucose usage by the cells and causes a transient increase in blood glucose level. At the same time, it inhibits genesis of glucose by the liver and prevents new glucose coming into blood except from absorption in intestine. So, if the person has not consumed carbohydrate, the blood glucose will start to decline which may go sometimes to dangerous low levels.

Energy substrate for tissues are generally carbohydrates or fats. Most tissues prefer to use glucose. But the brain can use only glucose and therefore, hypoglycaemia can cause coma and death. Further, alcohol promotes production of lactic acid from metabolic intermediates and bring about lactic acidosis. So when a person has consumed large amounts of alcohol and becomes unconscious, it may be difficult to differentiate simple alcoholic coma from hypoglycaemia and lactic acidosis.

Long term effects.

1. Gastritis and malnutrition.
2. Cirrhosis.
3. Permanent neurological and psychiatric problems-
 loss of memory, black outs and epilepsy, delusions, hallucinations, and irresponsible behaviour.
4. Feminization in males with shrinkage of genital organs.

Conclusion.

Is alcohol good or bad? No one can answer this question. The fundamental law of Pharmacology is "every chemical that goes in is a poison. Drugs should be administered after weighing the benefits against the harmful effects depending on the situation. The same could apply to alcohol. My expectation is that a person who administers alcohol to himself or herself should be aware of its properties before doing so. And should take full responsibility of the consequences of such administration.