

Exploring The Connections Between Alcohol and Chronic Traumatic Encephalopathy

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ABSTRACT

In the world of hard-hitting sports, a deadly consequence has come up in the past years: chronic traumatic encephalopathy (commonly known as CTE). This brain condition has long eluded scientists attempting to find a treatment and the effects of it are some of the worst we have ever seen. Moreover, the appearance of the disease has only increased in occurrence over recent years. Football, hockey, and other physical sports continue to get more and more popular across the world and if treatment for CTE is not found promptly, the effect of the dangerous sports will be seen in the players' brains like never before. CTE has claimed countless lives on the record and even more that have never quite been proven. However, though most believe the cause is the constant head trauma experienced by players, perhaps this mystery does not stop at just that. The specific causes of CTE and still not completely known, and this paper intends to answer that with at least one cause: alcohol. Alcohol has been a favorite among many players and its presence is undeniable in the sporting community. Its effects on the liver, kidney, and other organs are clear already, and perhaps after this research and more, its effects on the brain can become clearer as well. A connection between alcohol and CTE can be seen here in this research and this link can be built upon in efforts to create a treatment for the horrible disease, eventually hoping to render this issue nonexistent.

Introduction

Currently in the US, 85.6 percent of people ages 18 and older have reported that they have drunk alcohol at some point in their life. Moreover, alcohol consumption in athletes is just as prevalent, as studies have shown that about 50% of collegiate student-athletes are binge drinkers. However, the brain can often become an unintended victim of drinking. The brain is very vulnerable to external effects on it and these effects can not only cause permanent damage to the brain but even death in some cases. Overall, the consequences of this action can have a profoundly negative effect on your body that goes much deeper than what may be expected. One of the worst effects goes by the name of encephalopathy. Encephalopathy is a term for any disease that changes the function or structure of the brain. Encephalopathy can happen due to an array of reasons, such as the buildup of toxins in the blood going to the brain, repeated trauma to the brain, or infections, among other things. These reasons fall into different types of encephalopathies. Lots of specific research has been done on different types of encephalopathy and in this paper, each type will be described in detail with respect to the impact of alcohol on their development. This research intends to compare these different types of encephalopathies and use that comparison to further understand the similarities (using that to make more common claims about the types). The types, causes, symptoms, and treatments of three types of encephalopathy, hepatic encephalopathy, uremic encephalopathy, and Wernicke's encephalopathy will be compared with each other. A comparison of alcohol will be then done with chronic traumatic encephalopathy (CTE) in order to study the similarities and differences to generalize certain findings across all types, both reversible and irreversible, filling the gaps with comparison. The commonness of alcohol across many major types of encephalopathy is highlighted, and alcohol is a big

cause for most of these disorders. These findings can also hopefully lead to the prevention of the development of encephalopathy by the inhibition of alcohol. As each type is described in more detail, more light will be shed on the causes of this terrible disease and will lead to more information on the connection between alcohol and encephalopathy and the research here can be taken and used to make more knowledgeable strides in potential treatments and prevention for irreversible types of encephalopathy.

What Is Encephalopathy and Why Is There No Single Treatment for All Types?

Encephalopathy, as previously mentioned, is defined as damage or disease that affects the brain's function or structure. More specifically, when the brain is affected by trauma or internal disease, the structure and functionality alteration leads to a severely affected mental state. Encephalopathy is not a single disease, but rather a group and category of diseases and disorders. Encephalopathy can be divided into two types, reversible and irreversible. In reversible encephalopathy, symptoms may disappear when you cure the problem that's causing them. A person may even regain the original mental state that they had before the disease. Irreversible encephalopathy, on the other hand, usually means permanent damage to the brain and means that it is more than likely that your original mental state won't be restored. Each specific type of encephalopathy also has separate causes. Those causes are what differentiate the disorders in this particular case and are also what make it so that there is no one "save-all" treatment. Three of these specific disorders, each with different causes, were selected to be researched in detail and compared in an effort to make more strides in one common treatment. These disorders are hepatic, uremic, and Wernicke's encephalopathy.

We will be comparing these 3 types extensively to emphasize the difference between the 3, using that to make the common traits even more important (as common characteristics that exist despite large differences between the types can lead to a reasonable assumption that that cause might be able to be generalized across many types of encephalopathy).

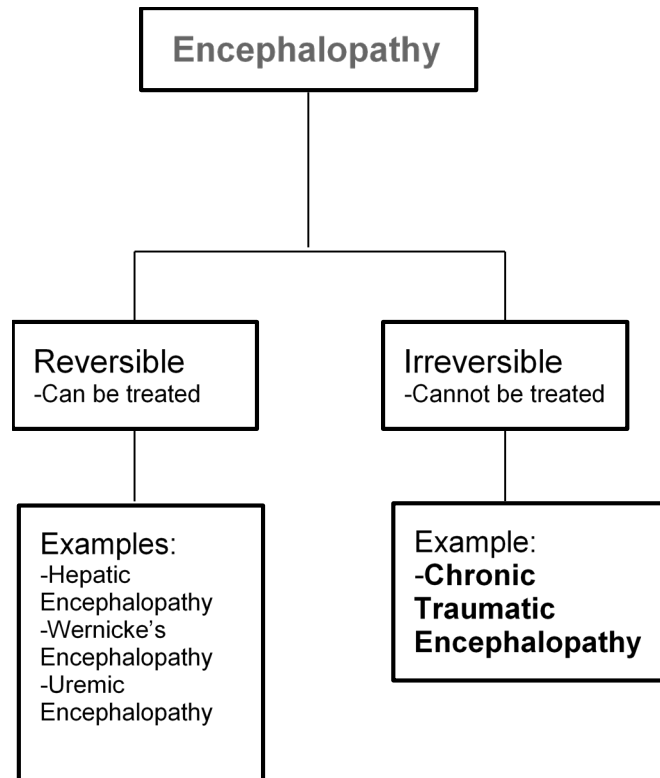


Figure 1. The breakdown of the types and categories of encephalopathy

Hepatic Encephalopathy

The first type of reversible encephalopathy that will be covered is hepatic encephalopathy. Hepatic encephalopathy is a disorder caused by liver disease. The liver is an organ that filters toxins out of the human blood. When it fails to work properly, it is unable to filter these toxins out of the blood and the toxins start to build up. When these toxins travel up to the brain and pile up, they can negatively affect brain function. Symptoms include anxiety, confusion, and coordination issues. The exact percentage of occurrence of all types of hepatic encephalopathy in the world is unknown. However, about 70% of people with cirrhosis may develop hepatic encephalopathy and hepatic encephalopathy is prominently associated with diagnoses of cirrhosis, which is believed to affect about 5.5 million people in the US.

There are 3 types of hepatic encephalopathy: Type A, B, and C. Type A is caused by acute liver disease. Acute liver disease is defined as a sudden disease of the liver after minimal pre-existing liver conditions. Type B happens in people with portosystemic shunts and no detected underlying liver disease. Type C is caused by chronic liver disease and cirrhosis. Cirrhosis occurs when the scar tissue that forms from liver damage builds up and makes it hard for the liver to function. These three types make up hepatic encephalopathy.

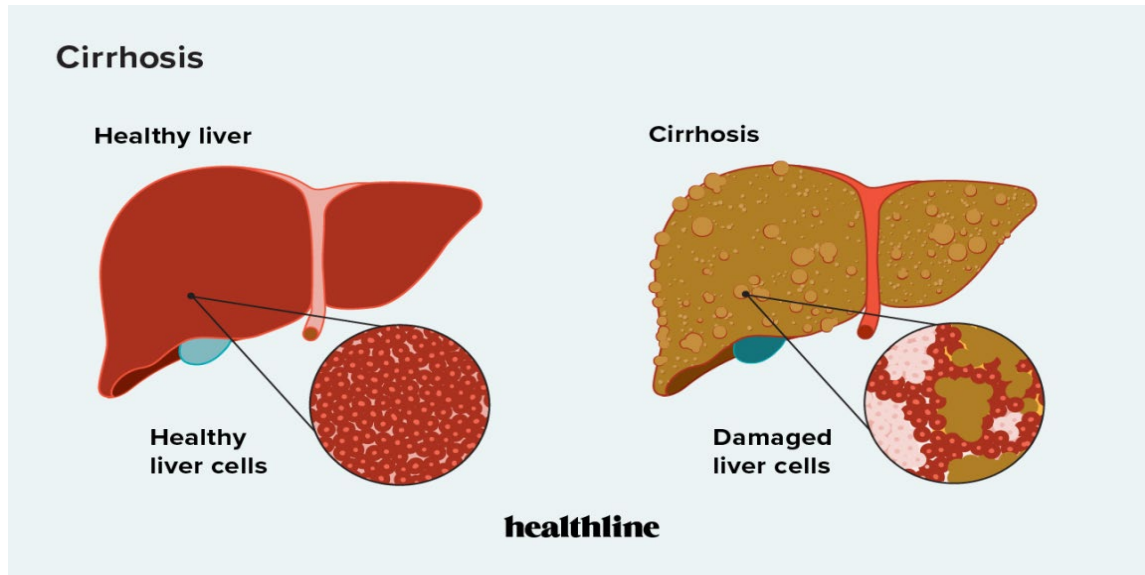


Figure 2. A healthy liver vs a cirrhotic liver, which is the cause of type C hepatic encephalopathy (Reviewed by Martinez, Illustrated by Hoffman, 2022)

Treatment for this disorder is done using antibiotics and laxatives. Antibiotics, such as rifaximin, lessen the number of natural bacteria that creates toxins from foods in the body. Laxatives, on the other hand, reroute toxins to the colon where they can be secreted and expelled out of the body. Prevention of hepatic encephalopathy comes with quality management of the body. Avoiding alcohol, a nutritious diet, and prescribed medication for liver disease can go a long way in keeping the liver as healthy as can be. Overall, hepatic encephalopathy is a liver disorder that comes along with liver failure causing a build-up of toxins. Preserving a healthy liver by staying away from negative items such as alcohol and cigarettes that can harm your liver and taking the correct medication when prescribed is the best solution.

Uremic Encephalopathy

The next type to cover is uremic encephalopathy. Uremic encephalopathy is a disorder that develops in people with chronic or acute renal failure. Renal failure is the failure of another organ that filters toxins out of blood, the kidney. With renal failure, toxins in the blood build up and go to the brain and cause impaired brain function. Early symptoms include a lowered ability to concentrate, drowsiness, and overall slower brain functions. More severe symptoms include emotional instability, disorientation, unnatural behavior, and just extremely lowered cognitive function (many times leading to coma). In terms of purely cause, this disorder finds high similarity to hepatic encephalopathy. However, there are two entirely different organs involved in each disorder, making both types relevant for the research.

Treatment for uremic encephalopathy is done with dialytic therapy and proper management of diet. Calcium and phosphate metabolism also must be monitored. After initiating dialysis the patient should see general bodily improvement despite potentially delayed EEG improvement. In fact, in patients with end-stage renal disease, unusual EEG readings may never return back to normal (though improvement will likely be seen after a few months). In diet, satisfactory protein intake should be maintained. Prevention for uremic encephalopathy also bears similarities to hepatic encephalopathy. Keeping the kidneys healthy by eliminating external factors (such as alcohol and smoking) that could potentially worsen its function would be the best prevention for the disorder. Overall, uremic encephalopathy is a kidney disorder that comes with renal failure causing the

build-up of toxins and the best solution is to maintain healthy kidneys by minimizing dangerous factors such as alcohol and poor diet, that can damage them.

Wernicke’s Encephalopathy

The third reversible type to cover is Wernicke’s encephalopathy. Wernicke’s encephalopathy is believed by many doctors to be the first of two steps in the Wernicke-Korsakoff Syndrome (Korsakoff Syndrome being the second step). This disorder can occur with a lack of vitamin B1, or thiamine. Thiamine assists your brain in converting sugar to energy and so when the brain does not get enough of this vitamin energy levels can lower and inhibit the brain’s function (encephalopathy). Wernicke’s encephalopathy is not something that develops symptomatically over time (Korsakoff’s syndrome is the gradual one), rather all the symptoms tend to show up suddenly. Some symptoms include balance and movement issues, memory issues, and vision problems, along with more minor but problematic issues in general brain functions (drowsiness, confusion, etc.). If treatment for Wernicke’s encephalopathy is not started immediately, it can lead to Korsakoff Syndrome.

Treatment for Wernicke’s encephalopathy is primarily the renewal of vitamin B1 in the body, likely using intravenous measures. This may have to be done for months depending on the severity of the disorder. Now generally, Korsakoff’s syndrome cannot be reversed. However, Wernicke’s encephalopathy specifically can be reversed if caught early enough. Treatment can not only reverse the disorder but also cure it nearly completely (though it may take months).

Prevention for this disorder starts with alcohol and dietary requirements. Strong, long-term alcohol use prevents the body from sustaining normal thiamine levels, and lack of thiamine, as previously mentioned, is the sole cause of Wernicke’s encephalopathy. As for diet, nutrients are necessary to maintain thiamine, as is the same with most vitamins. Not eating well can lead to being undernourished and possessing severely low vitamin counts. Overall, Wernicke’s encephalopathy is the first stage in the Wernicke-Korsakoff Syndrome that is caused by low levels of thiamine (vitamin B1), and the best solution to stay away from it is to avoid alcohol and eat well.

How Do These Types Compare? Is There One Common Enemy?

As each type of reversible encephalopathy was studied in detail, a glimmering commonality started to appear between them. The best solution for all 3 types was in fact simply the prevention of them and the prevention all started with the elimination of alcohol. Alcohol is a drug that is very diffusible through cell membranes and it is metabolized by most tissues (Rusyn et al., 2013), making all organs highly susceptible to damage. When alcohol enters a body, it can severely damage DNA and neural pathways, making its toxins essential to clear. One of these toxins that can be very harmful to the body is acetaldehyde. Acetaldehyde is formed through the oxidization of ethanol and its tendency to bind with proteins can make it very harmful as acetaldehyde-protein adducts are severely toxic to body cells. If acetaldehyde enters your bloodstream, it can damage your organ tissues and lead to liver or kidney failure, which leads to hepatic and uremic encephalopathy (as covered earlier). Overall, alcohol can be seen as a primary inducer of encephalopathy and its effects are clear.

Table 1. This figure shows a table comparing the causes, treatments, and prevention techniques of different types of reversible encephalopathies.

| | Cause | Treatment | Prevention |
|--|-------|-----------|------------|
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|---------------------------|--|---|---|
| Hepatic Encephalopathy | The liver's failure to filter blood causes the build-up of toxins in the bloodstream, eventually ending with the toxins making it to the brain. | Antibiotics and laxatives | Avoid alcohol , a nutritious diet, and prescribed medication for liver disease. |
| Uremic Encephalopathy | The kidney's failure to filter blood causes the build up of toxins in the bloodstream, eventually ending with the toxins making it to the brain. | Dialytic therapy and the proper management of diet. | Keep the kidneys healthy by eliminating external factors (such as alcohol and smoking) that could potentially worsen their function. |
| Wernicke's Encephalopathy | Lack of thiamine (vitamin B1) lowers energy levels in the brain. | The renewal of vitamin B1 in the body, likely using intravenous measures. | Avoid alcohol and eat well. |

Alcohol and Chronic Traumatic Encephalopathy

Chronic traumatic encephalopathy, otherwise known as CTE, is a progressive degeneration of the brain that is thought to be caused by repeated head trauma, though the cause is not exactly certain. Mental symptoms include “disordered memory and executive functioning, behavioral and personality disturbances (e.g., apathy, depression, irritability, impulsiveness, suicidality), parkinsonism, and, occasionally, motor neuron disease” (Weaver et al., 2013). CTE is believed to be irreversible and many times results in death. Ongoing research is still being done on potential cures to the disorder, though its highly damaging nature makes that a seemingly impossible task. CTE is prominently seen in athletes who play high impact sports. A study done on the topic showed that 80% of examined athletes that fell under this category had CTE (McKee et al., 2016). The alarmingly high number sums up the terrible effects of this disorder on athletes. Chronic traumatic encephalopathy is a neurodegenerative disorder that is mainly thought to be caused by head trauma and is mainly seen in high impact athletes.

However, comparing the reversible types of encephalopathy earlier, it was found that alcohol was a primary influencer in contracting the disorders and the degenerative traits of the toxins in the drug caused enormously negative impacts on the brain. Alcohol can also be seen commonly in the lives of many athletes. For instance, in 3 national studies on binge drinking in collegiate athletes, it was found that about 60% of male and 49% of female athletes were binge drinkers, compared to about 46% among male and 38% among female non-athletes (Leichliter et al., 1998; Nelson & Wechsler, 2001; Wechsler et al., 1997). It can be gathered from these studies that alcohol is not only present in a decent number of athletes' lives but a big part of their lives as well.

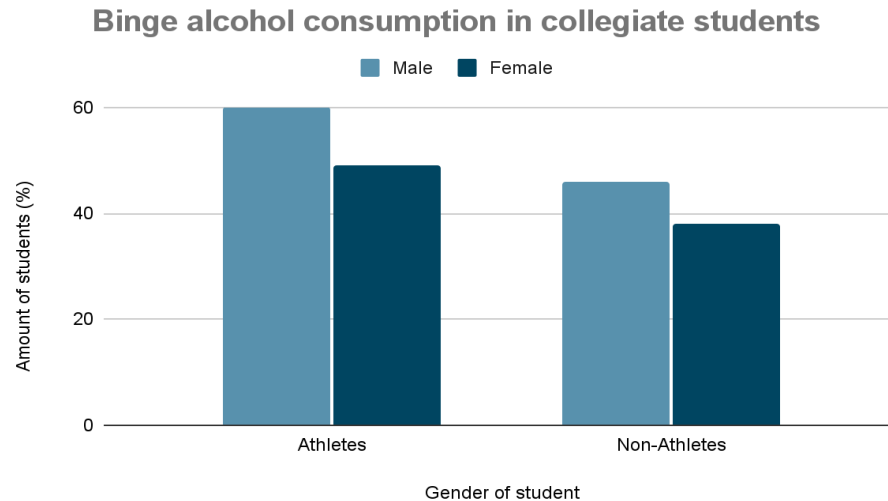


Figure 3-The results of 3 studies done on binge drinking in college students.

Alcohol can also be seen normally at the professional level of high impact sports. For example, former NFL player Akbar Gbajabiamila once called Friday Night the most dangerous night in the NFL largely due to the excessive amounts of alcohol that is consumed that night every week. Players can finally unwind after a long week of practice and games, and more often than not that means resorting to liquor as a relief. Alcohol is evidently not seen as a big concern in players' lives and its regular use is well documented.

The ubiquity of alcohol across major high impact sports cannot be denied and that paired with alcohol being a major cause in other types of encephalopathy raises the potential of alcohol making its own, even if minor, impact on chronic traumatic encephalopathy as well. Perhaps the presence of alcohol in an athlete's life makes him or her more susceptible to CTE to a certain extent. The prevention of alcohol can be a massive step in lowering the levels of CTE seen on a normal basis in high impact sports today.

Conclusion

In this paper, multiple different types of reversible encephalopathy have been studied, compared, and analyzed in order to gather more detail on the causes of each. Then the cause of alcohol, which was seen commonly across all types, was studied, looking into the different toxins that enter the bloodstream and how they make their way to the brain (with degenerative symptoms). These findings were then used to make a claim that alcohol is also a minor cause in perhaps the most well-known type of irreversible encephalopathy, chronic traumatic encephalopathy (CTE). It was discerned in multiple studies that alcohol is prevalent in the daily lives of many athletes who play high-risk sports and with that, it can be reasonably assumed that alcohol must have had some sort of impact on the players. Overall, it was found that alcohol is a major factor in the development of reversible encephalopathy and its effects may even play into irreversible types such as CTE. The data from the study done in this paper should be used to delve further into the connection between alcohol and encephalopathy in an effort to make more proven claims about the direct effect the toxins in alcohol can have in causing major brain damage. Eventually, this information can even be used to make progress in the treatment for CTE and other types of irreversible encephalopathies. All in all, it has been shown here that there is a potential link between alcohol and the contraction of CTE and that should not go unnoticed.

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