Alcohol and the central nervous system

Alcohol has a significant and widespread effect on the central nervous system ranging from intoxication to neurodegenerative dementia. This article reviews these effects and summarizes their management.

Alcohol is a widely consumed beverage that has significant effects on most organs of the body. The nervous system is a particular target for the damaging consequences of alcohol, caused either directly by the toxic effect of alcohol or by problems related to alcoholism. This article discusses the CNS effects of alcohol, as outlined in *Table 1*.

Direct effects

Intoxication

One of the more readily recognized effects of alcohol on the CNS is the state of intoxication. This typically manifests as disinhibition and euphoria although depression and drowsiness may predominate (Diamond and Messing, 1990). Cerebellar and vestibular functions may also be impaired and, when severe, cortical functions are affected, resulting in alcoholic stupor or coma.

Table 1. The effects of alcohol on the CNS

Direct effects	Intoxication
	Alcohol hangover
	Alcoholic blackouts and grayouts
	Alcohol withdrawal state and delirium tremens
	Cerebellar cognitive affective disorder
	Trigger for migraine and cluster headaches
	Effects secondary to hypoglycaemia
	Psychiatric features
	Fetal alcohol syndrome
Indirect effects	Ischaemic stroke
	Haemorrhagic stroke
	Wernicke's encephalopathy
	Korsakoff's psychosis
	Alcoholic pellagra encephalopathy
	Central pontine and extrapontine myelinolysis
	Subacute encephalopathy with seizures in alcoholics
	Head injury
	Alcoholic amblyopia
Direct and indirect effects	Seizures
	Marchiafava–Bignami disease
	Neurodegenerative dementia
	Alcoholic cerebellar degeneration
	Alcohol-associated movement disorders
	Alcoholic myelopathy
	Porphyria

Alcohol hangover

Another commonly experienced effect of alcohol is the hangover, the main features of which are headache, tremulousness, nausea, diarrhoea and fatigue. It is not clear if alcohol hangover has any significant effects on cognitive function or performance skills.

Alcoholic blackouts and grayouts

Episodes of anterograde memory loss induced by heavy alcohol consumption are called blackouts with partial forms referred to as grayouts (Perry et al, 2006). The amnesia may be permanent (en bloc), but most are transient (fragmentary) (Hartzler and Fromme, 2003). As with Korsakoff's psychosis, there may be a genetic predisposition to developing alcoholic blackouts.

Alcohol withdrawal state and delirium tremens

The alcohol withdrawal syndrome is a common problem when chronic alcohol consumption is interrupted voluntarily or as a result of concurrent illness. It manifests as anxiety, agitation and hallucinations with associated nausea, headaches and tremor. When severe, alcohol withdrawal seizures (discussed later) and delirium tremens may result. Delirium tremens is the worst form of the alcohol withdrawal syndrome and occurs about 48–100 hours after stopping alcohol. There is severe confusion and hallucinations, hypertension and hyperthermia, and it may result in death. Tachycardia and a previous history of alcohol withdrawal are predictive of the development of delirium tremens in subjects with alcohol dependence (Lee et al, 2005).

Cerebellar cognitive affective disorder

The cognitive effect of cerebellar damage is now well recognized and referred to as the cerebellar cognitive affective disorder. Alcohol is probably the most important cause of this and the main features are executive dysfunction, change in personality (disinhibition and inappropriate behaviour), language dysfunction (aggramatism, dysprodia and anomia) and spatial problems (Schmahmann and Sherman, 1998). Patients may have mood and psychotic thought disorders as well as obsessive-compulsive traits.

Dr Ibrahim Imam *is Consultant Neurologist in the Neurology Department, Torbay Hospital, Torquay, Devon TQ2 7AA*

Alcohol and headaches

Alcohol, especially red wine, is an established trigger for episodic cluster headaches and, to a lesser extent, chronic cluster headache (Evans and Schürks, 2009), affecting 50–80% of cases. It is reported that cluster headache sufferers are more likely than the general population to be alcohol abusers but large studies that have looked at this have given contradictory results.

Alcohol is also a trigger for migraine but the frequency of this is not well established. While previous studies have suggested that about a third of migraineurs report alcohol as a trigger, a review suggests that the actually frequency is probably less than 10% (Panconesi, 2008). Again, red wine seems to be the major alcoholic beverage implicated in triggering migraine attacks.

Effects secondary to hypoglycaemia

Alcohol-induced hypoglycaemic coma may be a result of failure of gluconeogenesis or a result of alcoholic non-diabetic ketoacidosis. Alcoholics are therefore prone to all the neurological consequences of hypoglycaemia including coma and transient or permanent neurological deficits.

Psychiatric features

Psychiatric manifestations of alcohol use include depression, severe anxiety, personality and behaviour disorders as well as psychosis. Delusional jealously is frequently associated with alcoholic psychosis although it is seen in only about 6% of cases, and is also seen in non-alcoholic psychosis (Soyka et al, 1991). Alcohol-induced insomnia is usually described as a psychiatric effect of alcohol and is present in about 60% of alcoholics (Brower et al, 2001).

Fetal alcohol syndrome

This is the consequence of the effect of alcohol on fetal development and presents with a typical facial appearance, mental and physical retardation as well as ophthalmic features like myopia, astigmatism and optic nerve hypoplasia.

Indirect effects

Ischaemic stroke

The relationship of alcohol consumption to the risk of ischaemic stroke is U-shaped rather than linear. While heavy drinking is an established risk factor for developing ischaemic stroke, light drinking appears to protect against it. Several mechanisms have been proposed as the mechanisms for the effect of heavy drinking on stroke risk including platelet activation, raised blood pressure or raised lipoprotein levels. Other possible mechanisms are cerebral vasoconstriction, dehydration-induced hyperviscosity as well as hyperhomocysteinaemia (Sacco et al, 1999).

The reduced risk of ischaemic stroke associated with light alcohol consumption is probably shared by all alcoholic beverages although red wine particularly seems to confer this benefit; polyphenols in red wine impair low density lipoprotein oxidation and also impair vascular smooth muscle cell migration thereby producing an antithrombotic effect (Iijima et al, 2002). The reduced risk is quite independent of any effect of diet, hypertension, diabetes, cardiac disease, current smoking, education, body mass index or high density lipoprotein levels (Sacco et al, 1999).

As for ischaemic stroke, heavy alcohol intake also increases the risk of cardioembolic and thromboembolic strokes but, in these cases, in direct proportion to the level of alcohol intake (Hillbom et al, 1999). It is possible that alcohol does this by inducing arrhythmias (the holiday heart syndrome) or by inducing increased blood flow (Hillbom et al, 1999). Alcohol also increases the risk of cardioembolic stroke by causing a toxic cardiomyopathy, and thromboembolic stroke by increasing the risk of traumatic cerebral dissection (Hillbom et al, 1999).

Haemorrhagic stroke

The risk of haemorrhagic stroke is also increased in a linear fashion by alcohol. Alcohol intoxication also increases the risk of aneurysmal subarachnoid haemorrhage. The mechanism of the increased risk may be a result of increased blood volume and pressure, and women appear to be at particular risk of this.

Wernicke's encephalopathy

Wernicke's encephalopathy is a degenerative problem which typically follows alcohol withdrawal syndrome. It is a consequence of thiamine deficiency which limits the brain's ability to use glucose. The major brain structures affected are the mamillary bodies, but the periaqueductal and periventricular grey matter, coliculli and thalamus are also involved (Sullivan and Pfefferbaum, 2009). It classically presents with the triad of confusion, ataxia and oculomotor disorders. The ataxia is typically trunkal while nystagmus and gaze palsies are the more common eye signs, complete ophthalmoparesis being rare (Diamond and Messing, 1990). Most patients are apathetic and inattentive although some may be agitated. Other reported features are ptosis, internuclear ophthalmoplegia and loss of pupillary reflexes (Diamond and Messing, 1990). Hypothalamic involvement may result in hypothermia and hypotension (Diamond and Messing, 1990).

The classical triad of Wernicke's encephalopathy is present in only about 10% of cases, resulting in a high misdiagnosis rate in life of about 80%. To improve diagnostic rates, practical diagnostic criteria with reported high specificity have been proposed. One suggests the requirement of two of the following to make a diagnosis: dietary deficiencies, oculomotor abnormalities, cerebellar dysfunction, and altered mentation or mild memory problems (Caine et al, 1997).

Korsakoff's psychosis

About 85% of cases of Wernicke's encephalopathy progress to Korsakoff's psychosis although a quarter of cases of Korsakoff's psychosis seem to arise de novo, with no prior history of Wernicke's encephalopathy (Blansjaar and Van Dijk, 1992). Korsakoff's psychosis is a chronic disorder predominantly of profound recent memory impairment and learning as a result of damage to the mamillary bodies and anterior thalamus. It occurs in a state of clear and alert consciousness and the amnesia is out of proportion to other cognitive deficits. Explicit memory is most affected with relative sparing of implicit memory. Affected subjects have no insight and confabulation is a recognized feature (Diamond and Messing, 1990). There may be a genetic predisposition and genetic variants involving the thiamine transporter gene have been described.

Alcoholic pellagra encephalopathy

Alcoholics are prone to developing niacin deficiency and could develop alcoholic pellagra encephalopathy as a result. This presents with confusion, myoclonus, cogwheel rigidity, gegenhalten and release of primitive reflexes (Estruch et al, 1997). Other reported features are urinary and/or faecal incontinence, movement disorders, seizures, hallucinations, anxiety and depression (Ishii and Nishihara, 1981). Skin lesions of pellagra are seen in only about a third of cases and none have the classic triad of diarrhoea, dementia and dermatitis seen in pellagra (Ishii and Nishihara, 1981). It is therefore often misdiagnosed and as a result it is recommended that all alcoholics presenting with encephalopathy should have nicotinic acid replacement alongside other vitamin replacement strategies.

Central pontine and extrapontine myelinolysis

Central pontine and extrapontine myelinolysis are usually a result of rapid correction of hyponatraemia. It is seen in alcoholics in whom it is not always associated with correction of hyponatraemia and could therefore be a direct effect of alcohol (Hagiwara et al, 2008). Features include spastic quadriparesis and pseudo-bulbar palsy. Magnetic resonance imaging of the brain in central pontine myelinolysis may show a trident-shaped pontine signal (the omega sign) indicative of the diagnosis (Biotti and Durupt, 2009).

Subacute encephalopathy with seizures in alcoholics

This encephalopathy is assumed to be of vascular origin rather than a result of alcohol withdrawal (Neidermeyer et al, 1981). It is seen in chronic alcoholics who present with encephalopathy, focal symptoms and signs (like hemiparesis, hemianopia or aphasia) and focal or generalized seizures. Non-convulsive seizures may contribute to the encephalopathy in some cases. Electroencephalography shows periodic lateralized epileptiform discharges (Niedermeyer et al, 1981) while magnetic resonance imaging may show transient high signal changes similar to those seen in status epilepticus. The outcome is favourable but recurrences have been reported (Niedermeyer et al, 1981).

Head injury

Alcoholics are prone to head injuries while intoxicated, with the consequences including skull fractures and intracranial haematomas. Alcohol intoxication worsens the consequences by associated respiratory depression (Kelly, 1995).

Alcoholic amblyopia

This is painless bilateral visual loss in subjects with chronic alcohol use. It is caused by deficiencies of thiamine and possibly other B vitamins. It is usually seen in alcoholics who smoke heavily and presents with scotomas and altered colour vision but normal fundi.

Direct and indirect effects

Seizures

Alcohol withdrawal seizures

Seizures are a typical feature of the alcohol withdrawal syndrome and account for about 25% of all patients with seizures admitted to hospital (Earnest and Yarnell, 1976). Alcohol raises the seizure threshold by enhancing the number and activity mainly of inhibitory GABA receptors; withdrawal on the other hand has the opposite effect, causing downregulation of these receptors and predisposing to seizures (Hillbom et al, 2003). There might be a genetic liability to alcohol withdrawal seizures (Hillbom et al, 2003).

High homocysteine and possibly prolactin levels may identify those at high risk of developing seizures in the alcohol withdrawal syndrome. Alcohol withdrawal seizures usually occur 6–48 hours after stopping alcohol (Hillbom et al, 2003) and typically do not exceed six generalized convulsions within 6 hours; more frequent seizures or seizures occurring over a longer period indicate other causes (Etherington, 1996). Repeated alcohol withdrawal and detoxification may result in permanent epileptogenic brain changes referred to as kindling; this results in increased risk of seizures with subsequent withdrawal states.

For mild to moderate alcohol withdrawal syndrome in which there are no withdrawal seizures, seizure prophylaxis is not advised (Bråthen et al, 2005). After a withdrawal seizure, benzodiazepines such as lorazepam, diazepam and chlordiazepoxide are the preferred agents for treatment and prophylaxis (Bråthen et al, 2005). Benzodiazepines are effective in alcohol withdrawal syndrome and prophylaxis of seizures and are widely used although anticonvulsant agents like carbamazepine are possibly as effective. Phenytoin is ineffective in treating alcohol withdrawal seizures, being no better than placebo, but it should be considered when the cause of the seizures is not clear or several factors are contributing to the seizures (Etherington, 1996).

Recurrent alcohol withdrawal seizures do not require long-term anticonvulsant therapy, indeed this may be detrimental to alcoholics because of erratic compliance and interaction with alcohol (Hillbom and Hjelm-Jäger, 1984).

Alcohol and epilepsy

Epilepsy is reportedly three times more common in alcoholics (Chan, 1985) and about 10–15% of patients with primary epilepsy may have worsening of seizures with alcohol (Heckmatt et al, 1990). This exacerbation is only seen with very heavy consumption; limited alcohol intake of 1–2 drinks a day in non-dependent patients does not appear to worsen seizure frequency or to affect blood anticonvulsant drug levels (Bråthen et al, 2005). Excessive alcohol use directly increases seizure risk in a dose-dependent manner and may be responsible for more than a quarter of all first seizures (Breen et al, 2005). It also underlies 10% of cases of status epilepticus which may, incidentally, be the first presentation of a seizure disorder in 44% of alcohol-related seizures (Alldredge and Lowenstein, 1993).

About 50% of seizures in alcoholics may be a result of an inherent liability to seizures as they are not related either to heavy alcohol consumption or to withdrawal (Devetag et al, 1983). Some have classified these cases as alcoholic epilepsy but they may simply represent epilepsy occurring in alcoholics.

Symptomatic seizures in alcoholics

In 20% of cases seizures in alcoholics may be symptomatic of other causes, including electrolyte derangements, head injury and stroke. The development of symptomatic seizures in these patients does not seem to be related to the level of alcohol consumption (Leone et al, 2002).

Marchiafava–Bignami disease

This is an encephalopathy usually seen in chronic alcoholics but not unique to them. It is the consequence of demyelination, necrosis and consequent atrophy mainly of the mid portion of the corpus callosum. It results in impaired consciousness and seizures, and may progress to coma and death. Two subtypes have been described depending on the severity and outcome. Type A is associated with significant impairment of consciousness and involves the whole corpus callosum; type B on the other hand only mildly impairs consciousness and has a better outcome (Heinrich et al, 2004). However, atrophy of the corpus callosum is seen in alcoholics who do not have features of Marchiafava–Bignami disease or other cognitive symptoms.

Neurodegenerative dementia

Alcohol-induced neurodegenerative dementia results from brain atrophy which seems to favour the frontal lobes. More severe stages are associated with hippocampal and corpus callosum involvement. This is possibly a result of the toxic effects of alcohol as well as of ceramides which are produced following alcohol-induced steatohepatitis (de la Monte et al, 2009). The dementia may manifest subtly as the dysexecutive syndrome in which there is difficulty with problem solving and visuospatial tasks with relative preservation of memory and intellect. More widespread involvement results in memory impairment.

The cognitive effects of alcohol are not related to the pathology seen in neurodegenerative dementias (Aho et al, 2009). Indeed moderate wine intake appears to reduce the risk of Alzheimer's disease in those without the ApoE-ε4 allele (Luchsinger et al, 2004) while light to moderate drinking may limit progression of mild cognitive impairment to dementia (Xu et al, 2009).

Alcoholic cerebellar degeneration

This is the result of the effect of alcohol (possibly in an idiosyncratic fashion) and nutritional deficiency on the cerebellum. While reportedly rare, postmortem studies show that about half are asymptomatic in life (Yokota et al, 2006). The anterior superior vermis and cerebellar hemispheres are particularly affected so it typically manifests with gait ataxia.

Alcohol-associated movement disorders

Alcohol consumption may result in several movement disorders. Alcohol-induced tremor is possibly an enhanced physiological tremor related to alcohol withdrawal. It is postural and may be limited to the hands or be more widespread when severe (Neiman et al, 1990). Other movement disorders related to alcohol withdrawal include transient facial or limb dyskinesias and transient Parkinsonism (Fornazzari and Carlen, 1982; Neiman et al, 1990).

Movement disorders may be the result of cerebellar involvement. Alcoholic cerebellar tremor usually involves the lower limbs and may also present with a resting tremor (Neiman et al, 1990). Asterixis may be seen with alcohol-induced hepatic encephalopathy while Parkinsonism and ataxia may be features of acquired hepatocerebral degeneration.

Alcohol may be the trigger for other episodic movement disorders and there are case reports in the literature of paroxysmal non-kinesogenic dyskinesia, ocular neuromyotonia, tardive dyskinesia and neuroleptic-induced akathisia and dystonia.

The ameliorative effect of alcohol is well recognized in essential tremor and myoclonus-dystonia, with the risk that some patients with these disorders become alcohol dependent (Neiman et al, 1990).

Alcoholic myelopathy

A myelopathy affecting mainly the posterior and lateral columns of the spinal cord may develop as a direct effect of alcohol or as a result of folic acid deficiency. In the

latter case, there may be associated optic neuropathy and peripheral neuropathy (López-Hernández et al, 2003).

Porphyria

Alcohol is one of the triggers for attacks of porphyria which can present with seizures, anxiety, restlessness, insomnia, depression and psychosis.

Conclusions

Alcohol has widespread effects on the CNS and these need to be considered in all patients with alcohol-related problems. BJHM

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Aho L, Karkola K, Juusela J, Alafuzoff I (2009) Heavy alcohol consumption and neuropathological lesions: a post-mortem human study. *J Neurosci Res* **87**(12): 2786–92

Alldredge BK, Lowenstein DH (1993) Status epilepticus related to alcohol abuse. *Epilepsia* **34**(6): 1033–7

Biotti D, Durupt D (2009) A trident in the brain, central pontine myelinolysis. *Pract Neurol* **9**(4): 231–2

Blansjaar BA, Van Dijk JG (1992) Korsakoff minus Wernicke syndrome. *Alcohol Alcohol* **27**(4): 435–7

Bråthen G, Ben-Menachem E, Brodtkorb E et al; EFNS Task Force on Diagnosis and Treatment of Alcohol-Related Seizures (2005) EFNS guideline on the diagnosis and management of alcohol-related seizures: report of an EFNS task force. *Eur J Neurol* **12**(8): 575–81

Breen DP, Dunn MJ, Davenport RJ, Gray AJ (2005) Epidemiology, clinical characteristics, and management of adults referred to a teaching hospital first seizure clinic. *Postgrad Med J* **81**(961): 715–18

Brower KJ, Aldrich MS, Robinson EA, Zucker RA, Greden JF (2001) Insomnia, self-medication, and relapse to alcoholism. *Am J Psychiatry* **158**(3): 399–404

Caine D, Halliday GM, Kril JJ, Harper CG (1997) Operational criteria for the classification of chronic alcoholics: identification of Wernicke's encephalopathy. *J Neurol Neurosurg Psychiatry* **62**(1): 51–60

Chan AW (1985) Alcoholism and epilepsy. *Epilepsia* **26**(4): 323–33

de la Monte SM, Longato L, Tong M, DeNucci S, Wands JR (2009) The liver-brain axis of alcohol-mediated neurodegeneration: role of toxic lipids. *Int J Environ Res Public Health* **6**(7): 2055–75

Devetag F, Mandich G, Zaiotti G, Toffolo GG (1983) Alcoholic epilepsy: review of a series and proposed classification and etiopathogenesis. *Ital J Neurol Sci* **4**(3): 275–84

Diamond I, Messing RO (1990) Neurologic effects of alcoholism. *West J Med* **161**(3): 279–87

Earnest MP, Yarnell PR (1976) Seizure admissions to a city hospital: The role of alcohol. *Epilepsia* **17**(4): 387–93

Estruch R, Nicolás JM, Salamero M et al (1997) Atrophy of the corpus callosum in chronic alcoholism. *J Neurol Sci* **146**(2): 145–51

Etherington JM (1996) Emergency management of acute alcohol problems. Part 2: Alcohol-related seizures, delirium tremens, and toxic alcohol ingestion. *Can Fam Physician* **42:** 2423–31

Evans RW, Schürks M (2009) Alcohol and cluster headaches. *Headache* **49:** 126–9

Fornazzari L, Carlen PL (1982) Transient choreiform dyskinesias during alcohol withdrawal. *Can J Neurol Sci* **9**(2): 89–90

Hagiwara K, Okada Y, Shida N, Yamashita Y (2008) Extensive central and extrapontine myelinolysis in a case of chronic alcoholism without hyponatremia: a case report with analysis of serial MR findings. *Intern Med* **47**(5): 431–5

Hartzler B, Fromme K (2003) Fragmentary and en bloc blackouts: similarity and distinction among episodes of alcohol-induced memory loss. *J Stud Alcohol* **64**(4): 547–50

Heckmatt J, Shaikh AA, Swash M, Scott DF (1990) Seizure induction by alcohol in patients with epilepsy experience in two hospital clinics. *J R Soc Med* **83**(1): 6–9

Heinrich A, Runge U, Khaw AV (2004) Clinicoradiologic subtypes of Marchiafava-Bignami disease. *J Neurol* **251**(9): 1050–9

Hillbom ME, Hjelm-Jäger M (1984) Should alcohol withdrawal seizures be treated with anti-epileptic drugs? *Acta Neurol Scand* **69**(1): 39–42

Hillbom M, Numminen H, Juvela S (1999) Recent heavy drinking of alcohol and embolic stroke. *Stroke* **30**(11): 2307–12

Hillbom M, Pieninkeroinen I, Leone M (2003) Seizures in alcohol-dependent patients: epidemiology, pathophysiology and management. *CNS Drugs* **17**(14): 1013–30

Iijima K, Yoshizumi M, Hashimoto M et al (2002) Red wine polyphenols inhibit vascular smooth muscle cell migration through two distinct signaling pathways. *Circulation* **105**(20): 2404–10

Ishii N, Nishihara Y (1981) Pellagra among chronic alcoholics: clinical and pathological study of 20 necropsy cases. *J Neurol Neurosurg Psychiatry* **44**(3): 209–15

Kelly DF (1995) Alcohol and head injury: an issue revisited. *J Neurotrauma* **12**(5): 883–90

Lee JH, Jang MK, Lee JY et al (2005) Clinical predictors for delirium tremens in alcohol dependence. *J Gastroenterol Hepatol* **20**(12): 1833–7

Leone M, Tonini C, Bogliun G et al (2002) Chronic alcohol use and first symptomatic epileptic seizures. *J Neurol Neurosurg Psychiatry* **73**(5): 495–9

López-Hernández N, García-Escrivá A, Pampliega-Pérez A, Alvarez-Saúco M, Martín-Estefanía C, Asensio-Asensio M (2003) Peripheral and optical myeloneuropathy in a folic acid deficient alcoholic patient. *Rev Neurol* **37**(8): 726–9

Luchsinger JA, Tang MX, Siddiqui M, Shea S, Mayeux R (2004) Alcohol intake and risk of dementia. *J Am Geriatr Soc* **52**(4): 540–6

Neiman J, Lang AE, Fornazzari L, Carlen PL (1990) Movement disorders in alcoholism: a review. *Neurology* **40**(5): 741–6

Niedermeyer E, Freund G, Krumholz A (1981) Subacute encephalopathy with seizures in alcoholics: a clinical-electroencephalographic study. *Clin Electroencephalogr* **12**(3): 113–29

Panconesi A (2008) Alcohol and migraine: trigger factor, consumption, mechanisms. A review. *J Headache Pain* **9:** 19–27

Perry PJ, Argo TR, Barnett MJ et al (2006) The association of alcohol-induced blackouts and grayouts to blood alcohol concentrations. *J Forensic Sci* **51**(4): 896–9

Sacco RL, Elkind M, Boden-Albala B et al (1999) The protective effect of moderate alcohol consumption on ischemic stroke. *JAMA* **281**(1): 53–60

Schmahmann JD, Sherman JC (1998) The cerebellar cognitive affective syndrome. *Brain* **121**(pt 4): 561–79

Soyka M, Naber G, Völcker A (1991) Prevalence of delusional jealousy in different psychiatric disorders. An analysis of 93 cases. *Br J Psychiatry* **158:** 549–53

Sullivan EV, Pfefferbaum A (2009) Neuroimaging of the Wernicke-Korsakoff syndrome. *Alcohol Alcohol* **44**(2): 155–65

Xu G, Liu X, Yin Q, Zhu W, Zhang R, Fan X (2009) Alcohol consumption and transition of mild cognitive impairment to dementia. *Psychiatry Clin Neurosci* **63**(1): 43–9

Yokota O, Tsuchiya K, Terada S et al (2006) Frequency and clinicopathological characteristics of alcoholic cerebellar degeneration in Japan: a cross-sectional study of 1,509 postmortems. *Acta Neuropathol* **112**(1): 43–51

KEY POINTS

- The effects of alcohol on the central nervous system are widespread and significant.
- Alcohol may directly affect the central nervous system or cause its effects by indirect mechanisms, usually in the form of nutritional deficiency.
- Alcohol should be considered in subjects presenting with neurological symptoms as many of the effects are potentially treatable or reversible.