13th July 2023

[redacted]

Aleksandra Jez
NSW Crown Solicitor's Office

Special Commission of Inquiry into LGBTIQ hate crimes Special Commission re death of Samantha Rose

I have been asked to review the files and produce a toxicology report.

Background

I qualified in 1989 from the University of Edinburgh, Scotland as a medical practitioner (MB ChB). I have been a specialist general physician and clinical toxicologist since 1998, working previously as the Director of the National Poisons Information Service Guy's and St Thomas's Hospitals, UK and on call for Australia giving expert toxicology advice through the NSW Poisons Information Centre. I am a Fellow of three Royal Colleges of Physicians, Fellow of the American College of Medical Toxicology, Fellow of the American Academy of Clinical Toxicology and Regional Adviser to NSW, Queensland and the ACT for the Royal College of Physicians of Edinburgh. I remain clinically active in the care of both general medical and clinical toxicology patients.

I am currently Director of Medical Education and consultant physician and toxicologist at Fiona Stanley Hospital, Western Australia. I have diagnosed and treated many patients with toxicity from drugs and chemical including toxic alcohols.

The case

This is articulated in the letter of instruction of 6th June 2023 by Aleksandra Jez.

Questions posed by Aleksandra Jez in her letter of instruction of 6th June 2023;

1) ***Please outline the manner in which methylated spirits or 'turps' are absorbed and metabolised, including any cognitive effects of oral consumption.***

Methylated spirit is widely available for sale to the public and is used as either as a solvent or as fuel. Methylated spirits contain toxic chemicals like methanol, and sometimes bittering agents (e.g. Bitrex) that are added to the main ingredient ethyl

alcohol (ethanol) to make it “unfit for drinking”. Methylated spirits contains 70-99% ethanol, with additional methanol at roughly 5%-10%. It also commonly contains bittering agents to give it an intensely unpleasant taste to discourage consumption by recreational users, and/or magenta colouring to allow it to be identified as “unfit for drinking”. Although bottles of methylated spirits are marked as containing “denatured alcohol” the ethanol contained within is not altered in its chemistry. The “denatured” refers to the addition of other agents such as colouring, bittering agents and methanol.

Methylated spirits is toxic to humans by nature of its very high ethanol (“alcohol”) content, and even taking a small drink of it can thus lead to headache, dizziness, dyspepsia (indigestion), nausea and central nervous system depression. The fatal dose of ethanol in adults is approximately 5-8 g/kg body weight (6-10 mL/kg absolute ethanol). Despite its poisonous content of ethanol at high concentration and methanol at much lower concentrations, methylated spirits is sometimes consumed as a surrogate (cheap) alcohol as it is not subject to recreational alcohol taxation by the government.

If methylated spirits is “home brewed or black market obtained” it may have much higher methanol content than 5-10% which is not noticeable to the user but its consumption can also result in temporary blindness or death. However, the risk of permanent optic nerve damage is remote unless large amounts have been consumed.

Ethanol (in methylated spirits - also methanol) is rapidly absorbed from the human gastrointestinal tract. Adults absorb 80-90% of ingested alcohol within 1 hour and metabolise it at a rate of 7-15 g per hour (reducing blood concentrations of ethanol by approximately 15-20 mg/dL (0.015-0.020 g/dL) per hour). Ethanol is rapidly absorbed from the gastrointestinal tract into the blood stream providing systemic exposure to the chemical. Approximately 20% of consumed alcohol is absorbed into the blood stream via the stomach. The small intestine more efficiently absorbs alcohol than the stomach and can absorb most of the alcohol after it has left the stomach.

Ethanol is metabolised in the body by liver enzymes, the primary ones are alcohol dehydrogenase, aldehyde dehydrogenase, specific forms of cytochrome P450 and catalase. Most (90%) of the ethanol is metabolised by the liver with smaller amounts metabolised in the stomach. Some ethanol is excreted from the body via the lungs in breath and via the kidneys into urine or in sweat.

Ethanol is a known neurotoxin and central nervous system depressant. Even at low to moderate blood ethanol levels, it has been observed to impair balance, visual focus, reaction times, executive judgment and to change a person’s behaviour (e.g. Dry et al).

Laboratory studies which test human performance on various tasks designed to

detect ethanol effects on specific brain systems have identified substantial impairments across multiple measures of cognitive (e.g. information processing) and psychomotor functions (e.g., eye-brain-hand-foot coordination) that directly then bear on the risk of all forms of injury. An extensive review of more than 200 controlled human experimental studies on the acute effects of ethanol on the brain and central nervous system has discovered impairments of;

- visuo-motor control
- divided attention
- focused attention
- reaction time
- response inhibition
- and working memory.

These above effects were highly consistent at blood/breath ethanol concentrations (BACs) of 0.05% and higher, and some effects were found even at lower levels (Zoethout et al).

Reviews of human neuroimaging studies consistently support findings of diminished cognitive and psychomotor function seen in the above neurological laboratory experiments (Bjork et al). Several reviews, incorporating studies with a wide range of study protocols, show that even beginning at low levels of ethanol, acute alcohol intake reduces overall brain glucose metabolism (which is a proxy for neuronal activity measured by PET scanning) and increases metabolism of acetate (a product of acetaldehyde oxidation) in a dose–response manner. Reduced glucose metabolism is most concentrated in the cerebellum (implicated in motor impairment), while limbic regions (implicated in reward-seeking behaviour and addiction) show increased metabolism (Bjork et al, Jacob et al, Van Skike et al). These studies also show that brain centres most affected by alcohol (i.e., cerebellum, hippocampus, occipital cortex, striatum, amygdala) are regions where balance, movement coordination, attention focus, self-control, processing of emotional stimuli (e.g., threat detection), motivation and reward-seeking, spatial learning and memory are believed to occur.

There is strong concurrence, therefore, between reviews of experimental human laboratory studies demonstrating cognitive and performance deficits and neuroimaging studies demonstrating pharmacological and physiological actions of alcohol on the brain that strongly implicate causal pathways to injury risk. These facets are expected to be relevant to both Samantha Rose and Ms Durward and the personal interactions between the two if they both consumed methylated spirits at the same time. It is crucial, however, to bear in mind that the relationship between ethanol and injury is by no means inexorable. Outside of the laboratory, observational studies confirm every-day experience that not all alcohol use, or even intoxication, necessarily results in injury. Risk of injury from alcohol can be influenced by individual differences and expectancies about appropriate or permissible behaviours (Exum et al, Wells et al, Attwood et al) as can social and cultural norms (e.g., community acceptance or

rejection of drinking and driving). External factors such as the social setting (e.g. at home, in the pub, at a park), price and physical availability of alcohol also have major impacts on alcohol-caused injuries at a population level (Barbor et al, Cherpitel et al).

Although at times controversial, there is also robust evidence supporting the conclusion that alcohol use by victims at the time of the offence increases the risk of interpersonal violence (Duke et al, Kuhns et al). The role of alcohol use by females and interpersonal violence has been less well-studied than for males, however, female alcohol use has also been identified as a risk factor for both perpetration and victimisation. Moreover, alcohol use is more strongly linked to victimisation among women than victimisation among men in intimate partner violence (Cafferky et al, Devries et al). In this case Ms Durward, a possible suspect under investigation in the matter of the death of Samantha Rose, had a history of repeated violence and methylated spirits consumption.

In addressing this matter, please also comment on:

a) The immediate and longer-term effects of oral consumption, with reference to the requisite quantities and frequencies of consumption for those effects to occur;

The acute (i.e. immediate) effects of methylated spirits ingestion are predominantly those of acute ethanol ingestion.

"Ingestion may cause irritation of the gastrointestinal tract, vomiting and diarrhoea. Ingestion may also cause nausea, headache, dizziness and intoxication. Ingestion of large amounts of methylated spirits may cause unconsciousness.

Early symptoms: Occur within 1 hours, mild CNS depression, nausea, vomiting and abdominal pain.

Late symptoms 12-24 hours: headache, dizziness, vertigo, blurred vision and photophobia. Severe symptoms: Tachypnoea (in response to the metabolic acidosis), drowsiness and blindness (due to methanol).

Mild intoxication – ethanol concentration <1.8 g/L (0.18 g/dL, **180 mg/dL**, 39 mmol/L) results in impaired visual acuity, reaction time and co-ordination. Emotional lability may occur (Toxbase).

Moderate intoxication- ethanol concentrations 1.8-3.5 g/L (0.18-0.3.5 g/dL, **180-350 mg/dL**,39-76mmol/L) results in slurred speech, diplopia, blurred vision, ataxia, inco-ordination, blackouts, sweating, tachycardia, nausea, vomiting and incontinence. Hypoglycaemia may be delayed up to 36 hours in previously fasted or malnourished individuals (Toxbase).

Severe intoxication – ethanol concentrations 3.5-4.5 g/L (0.35-0.45 g/dL, **350-450 mg/dL**, 76-98 mmol/L) results in cold clammy skin, hypothermia, hypotension, stupor,

coma, dilated pupils, depressed or absent tendon reflexes. Severe hypoglycaemia, convulsions, respiratory depression and metabolic acidosis may occur (Toxbase).

Cardiac arrhythmias such as atrial fibrillation (AF) and atrioventricular block have been recorded after ethanol consumption, even at low levels in those predisposed to arrhythmias e.g. large left atrium.

Potentially fatal intoxication – ethanol concentration > 4.5g/L (0.45 g/dL, **450 mg/dL**, 98 mmol/L) results in deep coma, respiratory depression or arrest and circulatory failure (Toxbase)."

In summary a blood ethanol concentration of 1.8 g/L (180 mg/dL, 39 mmol/L) would usually cause intoxication and concentrations of 3.5 g/L (350 mg/dL, 76 mmol/L) are associated with stupor and coma. Concentrations of > 4.5 g/L (450 mg/dL, 98 mmol/L) are often fatal.

Women are likely to have higher blood alcohol concentrations than men drinking the same amount of ethanol. This is due to women generally being smaller and having a higher fat to water ratio than men, resulting in less fluid in their bodies in which the alcohol is distributed/ diluted than men. They may also have fewer of the enzymes needed to metabolise the ethanol (Health Protection Agency monograph 2014).

Methanol if present in abnormally high quantities in methylated spirits can cause acute intoxication and damage to the optic nerve causing blindness due to the production of a toxic metabolite (formic acid). At 5-10% methanol in manufactured methylated spirits, the production of significant quantities of the optic toxic metabolite should not occur because the metabolic enzymes are "busy" metabolising all the ethanol i.e. competitive metabolism.

Chronic (longer term) effects

Alcohol-dependent people who have built up a tolerance to alcohol may use methylated spirits as their drink of choice due to the high alcohol content irrespective of cost or presence of bittering agents. This may be the case in Ms Durward and/or Samantha Rose. Because of the high amount of alcohol present addiction to methylated spirits occurs in a matter of daily or almost daily drinking over several months. In my clinical experience patients who use methylated spirits are generally chronic alcohol dependent people. Some people use methylated spirits because it is cheap, although for a few it is the substance of choice regardless of cost.

Those people who regularly drink alcohol or ethanol containing substances such as seems likely in the case of Ms Durward scan develop a central nervous system tolerance which means they may only be slightly impaired at blood ethanol levels of 200–300 mg/dL (Jones and Holmgren 2003). However, my clinical experience suggest

they also drink more over time to "compensate" for the physiological tolerance i.e. to get the recreational effects of the alcohol.

The effects of repeated (i.e. daily / many times per week) methylated spirits consumption are those of excessive repeated alcohol consumption. This includes toxicity to the liver including cirrhosis, and to the cerebellum and peripheral nerves both causing difficulties with balance. Chronic exposure to ethanol can also result in disease of the pancreas (pancreatitis), heart conditions (dilated cardiomyopathy), pneumonia (due to aspiration), damage to the brain (by direct neurotoxicity) and nervous system (by direct neurotoxicity and concurrent poor food intake and vitamin B1 and B6 depletion) and suppression of the immune system (Ben-Eliyahu et al 1996). Chronic exposure to ethanol in the context of alcoholic beverages has also been associated with a higher risk of some cancers. Ethanol and its metabolite acetaldehyde are considered to be carcinogenic (Baan et al 2007). Oral ethanol exposure increases the risk of developing cancers of the mouth, throat, oesophagus, large bowel and rectum, breast and liver. The risk of cancer increases with the frequency and amount of exposure to ethanol over years. Ethanol intoxication suppresses the natural killer cell activity, which may underlie the association between alcohol intake and cancer (Ben-Eliyahu et al 1996).

(b) The impact of oral ingestion on memory recall;

Acute systemic exposure to ethanol and its metabolites through methylated spirits ingestion can result in behavioural and motor coordination changes at low level blood alcohol concentrations. Consumption of ethanol is associated with an increased risk of injury, domestic violence and intentionally inflicted harm (Borges et al 2006; Taylor et al 2010) as discussed above. Higher levels of blood alcohol lead to depression of the respiratory system, with the possibility of coma and death.

Other symptoms of acute alcohol intake include loss of memory recall and nausea and vomiting (UK Health Protection Agency monograph). Surprisingly, alcohol can both enhance and impair memory, depending on when it is administered. Alcohol impairs learning when it is present during encoding (i.e. when experiences are happening) (Zorumski et al, 2014) but it enhances learning and memory for salient environmental stimuli when it is present during consolidation i.e. following stimulus presentation (Parker et al, 1980 and 1981). The impact of alcohol on emotional memory is more controversial (Weafer et al, 2016).

and

(c) Whether mixing methylated spirits with cordial would affect the degree to which a person is impacted by consumption.

In the same way that adding “mixers” to commonly consumed spirits such as whisky or gin dilutes the alcohol, adding cordial (and presumably water) should result in slowing of the effect of the alcohol on the body by slowing the rate of absorption of the alcohol. The “area under the curve” of alcohol concentration in blood over time would remain the same with or without cordial, but the peak alcohol concentration would be higher and occur earlier (within 1 hour) if “straight” spirits are consumed vs spirits with mixers.

(2) The estimated toxicity of methylated spirits;
The answer to this question is articulated under 1. Above.

(3) Any other matter arising, not addressed in response to (1)-(2), on which you wish to express an opinion.
Nil additional.

I wish to pass on my condolences to the families of Ms Rose and Ms Durward for their loss.

I, Professor Alison Jones, acknowledge for the purpose of Rule 31.23 of the Uniform Civil Procedure Rules 2005 that I have read the Expert Witness Code of Conduct in Schedule 7 to the said rules and agree to be bound by it.

Yours sincerely

Professor Alison L Jones
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Specialist Physician and Clinical Toxicologist,
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