

THE TOX LAB

Podcast Transcript

Episode 12: Slushie Poisonings

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TRANSCRIPT

Hi everyone, welcome back to The Tox Lab. I'm Rebecca.

I'm Rob. This week on The Tox Lab, we're looking at the surprisingly sinister side of slushies.

The distant cousin of the frozen margarita, or the extended relative of sorbet.

I could really go for a frozen margarita right now.

This week we're looking at the darker side of that frozen drink children have been enjoying for about 70 years or so.

Is it really that long?

Believe it or not, it is.

What's your earliest memory of a slushie?

I think it must have been at one of those soft-play birthday parties, getting to pick the blue raspberry flavour, drinking it, and then showing everyone that your tongue had turned blue.

That is probably my earliest memory too. Mine was at a bouncy castle party at a leisure centre, with the cafe overlooking the running track. Like you, I went for a blue one.

And I remember being slightly disappointed, because after about 10 seconds it felt like you'd sucked all the flavour out and were just left with ice.

Yes, but the best bit is the coloured tongue.

Definitely the novelty.

We're going to be looking at this idea of slushie poisoning. This episode was suggested by one of our listeners, so thank you very much for that.

Slushies have been in the news over the last few years because there have been a number of cases of children becoming quite unwell after drinking them. We wanted to look at what was going on in those cases.

But before we get into that, I did want to jump in on the history of the slushie. The story goes back to the 1950s and a man called Omar Knedlik, who had a faulty soda machine at his restaurant. He ended up keeping bottles of soda in the freezer, and customers apparently loved the semi-frozen drink he served them.

He eventually marketed the idea and went on to produce one of the first slushie machines.

Very cool.

That was awful.

Did you mean to say that?

Probably.

From the 1960s through to the 1980s, slushies became a normal feature of cinemas, corner shops, leisure centres, and so on. They really are a familiar cultural thing.

Yes, they are kind of everywhere. The Simpsons has Squishies, for example.

But something changed more recently, didn't it?

Yes. To create that classic slushie texture, you need something that stops the liquid freezing completely solid. Traditionally, one of the easiest ways to do that was with a lot of sugar.

But since the UK sugar tax was introduced in 2018 to try to reduce childhood obesity, glycerol has often been used as a substitute for some of that sugar in slushies to maintain the familiar texture.

The reason slushies stay in that semi-frozen state is that adding something like sugar or glycerol lowers the freezing point of water. So the liquid does not freeze solid at zero degrees, and if you get the balance right you end up with that semi-solid consistency.

So historically it was a very sugary product. More recently, glycerol has been used instead, and it was only after that shift that people started talking about slushie poisonings.

Exactly. There have been several cases over the last few years, including some that were reported in Scotland in 2021 and 2022, involving very young children who became unwell after drinking slushies.

Symptoms included nausea, reduced consciousness, headache, hypoglycaemia, and in at least one case a seizure. There have also been other reported cases in places like Birmingham, Dublin, London, Newcastle, and Manchester.

So we have a cluster of similar presentations following slushie ingestion, but the exact mechanism is still not fully pinned down.

Let's talk a bit about glycerol. Glycerol is not inherently poisonous in the way people might imagine. It is a sugar alcohol and a normal by-product of metabolism. Your body generates glycerol when it breaks down triglycerides.

So what is happening here is not that glycerol is some obviously toxic industrial chemical. The issue is that we may be giving quite a large glycerol load to a very small person.

And the cases all seem to be in children.

Yes. Although I do know an adult who says he feels nauseated after drinking modern slushies, so clearly some adults do notice effects too.

Worst-case estimates suggest slushies can contain up to around 50 grams per litre of glycerol, which is a lot.

And unlike intense artificial sweeteners, where tiny amounts make something taste sweet, you need a substantial amount of something like sugar or glycerol to produce the freezing-point effect in a slushie. That is why the glycerol content can be so high.

You mentioned inherited disorders of metabolism. Can you talk us through where people think the pathway might be going wrong?

If we think back to those horrible metabolic pathway charts that used to be on school laboratory walls, glycerol can be used as an alternative fuel source during fasting. It can be channelled into gluconeogenesis, where substances like glycerol and amino acids are converted back into glucose.

To do that, the body relies on a number of enzymes. Some people may have partial deficiencies or reduced activity in those pathways, which could mean that when they are given a very large glycerol load, the pathway becomes stressed and intermediate compounds build up instead of everything flowing neatly through to glucose.

So the idea is that a very large, non-physiological glycerol load could overwhelm the system in susceptible children, leading to build-up of intermediates and reduced glucose production.

Exactly. That could help explain why some of these children present with hypoglycaemia.

And the seizures could potentially be secondary to that hypoglycaemia?

Yes, although another possibility is the osmotic effect of glycerol. Glycerol can draw water out of cells into the bloodstream, so you could get cerebral dehydration, which might also lower the seizure threshold.

So it may be multifactorial.

It is also important to say that this does not seem to happen to everybody. Lots of children must have drunk slushies during this period and most of them did not end up in hospital.

That suggests there may be some underlying susceptibility, perhaps minor polymorphisms or partial impairments in metabolic pathways, but nothing dramatic enough to have been picked up previously.

Yes. We know there are recognised inborn errors such as glycerol kinase deficiency, but those are much more obvious disorders and children with severe forms tend to present early and can do very badly without treatment.

So what we may be dealing with here is not a full inborn error, but some subtler susceptibility that only becomes apparent when a child is suddenly given a very large glycerol load.

That is also why the Food Standards Agency ended up recommending that slushies should not be given to children under the age of four.

Yes, because part of the issue is probably body weight and the ability to tolerate the load.

One of the enzymes people have discussed in relation to this is fructose-1,6-bisphosphatase, which is involved in gluconeogenesis. If the pathway becomes overloaded with glycerol-derived intermediates, you can get accumulation of phosphorylated three-carbon sugars, depletion of phosphate, reduced ATP generation, and impaired glucose production.

Those intermediates can also be shunted toward pyruvate and lactate, which can contribute to metabolic acidosis, and increased acetyl-CoA can contribute to ketone production.

You also get changes in the NAD to NADH ratio, don't you?

Yes. Large amounts of glycerol can increase NADH generation and reduce the NAD to NADH ratio. That, in turn, can inhibit gluconeogenesis and other metabolic pathways, which may contribute to transient hypoglycaemia and lactic acidosis.

So treatment is really supportive, isn't it? Give glucose if needed, manage symptoms, and let the metabolic load clear.

Yes, essentially.

We could not find a formal published case series on the slushie cases themselves, but we did find a published case report of glycerol toxicity that is probably relevant.

Yes, and it is quite a strange one. A 42-year-old man presented to hospital after drinking 600 millilitres of vanilla essence.

That sounds revolting.

It really does. The suggestion was that he had alcohol use disorder and may have been trying to become intoxicated, because some vanilla essence preparations contain a substantial amount of ethanol.

But some cheaper formulations use glycerol instead of alcohol, and that turned out to be relevant here.

He presented with tonic-clonic seizures, sluggish pupils, urinary and faecal incontinence, sinus tachycardia, and a lactate of 21 millimoles per litre. His blood glucose was mildly raised, but his ethanol was not particularly high, which made the team suspect something other than ordinary alcohol intoxication.

He required significant treatment. He was given intravenous midazolam, which is a benzodiazepine, and levetiracetam as an anticonvulsant. Eventually he had to be intubated because the seizures were not settling.

Laboratory tests showed a raised serum osmolality, an osmolar gap, and an anion gap, so the team initially suspected a toxic alcohol ingestion such as methanol or ethylene glycol.

So they treated him along those lines?

Yes. They did not have fomepizole available, which is one of the standard treatments, so they used ethanol via a nasogastric tube instead, which sounds counterintuitive but is actually a recognised treatment approach for toxic alcohol poisoning.

They also started continuous venovenous haemofiltration to help clear the suspected toxin.

When they eventually did an organic acid screen, they found elevated glycerol and realised that the vanilla essence he had consumed was glycerol-based rather than ethanol-based.

He remained intubated for about three days. After extubation he had some transient encephalopathy and word-finding difficulty, but that resolved within 24 hours, and he was back to baseline by day five.

So that is a really severe case of glycerol toxicity, but it probably reflects the same sort of pathway that may be relevant in the slushie cases.

Yes. The seizures were thought to be due to cerebral dehydration from the large glycerol load, and the lactic acidosis fits with the same metabolic disturbance we have been talking about.

This is an interesting example of unintended consequences, isn't it? There was a clear public health aim to reduce sugar intake in children. Sugar in soft drinks contributes to obesity. Replacing some of that sugar with glycerol may have looked like a sensible move. But that has then uncovered a different acute risk in some children.

It is a really difficult balance. Glycerol is not something people would have immediately thought of as dangerous, and yet here we are.

Exactly. And now the advice is that children under four should not be given slushies.

Which is awkward, because these are not products designed for adults. They are bright blue, bright green, very obviously child-oriented products.

Yes. And even for older children, there is advice not to overdo it. The Food Standards Agency also recommended that manufacturers use the minimum amount of glycerol needed to get the desired effect.

And there has been concern about those novelty refill cups where children could keep going back for more throughout the day.

We should point out that this issue only applies where glycerol is being used in slushies. In places still using very sugary traditional recipes, you are not going to get glycerol toxicity, although obviously excessive sugar brings its own problems.

So in summary, slushie poisoning is a real thing, but more accurately it is glycerol intoxication associated with slushies.

What is the practical advice? If you are out and about and your child wants a slushie, or indeed you want one yourself, what should people do?

I still like slushies, although preferably alcoholic ones.

That is a different episode. Frozen margarita toxicology can come later.

But yes, the main point is just to be aware that the recipe may have changed and that these products can contain quite a lot of glycerol. So do not overdo it.

And be aware of the symptoms we have talked about: nausea, lethargy, reduced consciousness, seizures, not feeling right after drinking one, especially in a young child.

Yes. If a child looks unusually sleepy, sick, confused, or unwell after having a slushie, seek advice and get help.

I think we are going to wrap it up there. I hope you have enjoyed listening.

Do give us a like and a follow on social media or on Spotify. You can find us on Instagram at @the_tox_lab.

We would welcome any feedback, so feel free to comment on any of our posts or send us a message. If you have more topics you would like us to cover, we would love to hear from you.

Hope you all have an amazing week, and we will see you next time. Bye.