

Episode 48: Mushroom Toxicology - Trends, Toxins, and Mislabeled Products

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Transcript

Hey everyone, welcome back to the Tox Lab. I'm Rebecca. I'm Rob. This week, we've got a bit of an autumn themed episode on the cards, haven't we?

Autumn is definitely here. I'm really happy about it. Or fall for our American listeners. Yes.

The nights are drawing in, it's a bit colder, leaves are turning brown. I'm going to say possibly the most controversial thing I've ever said on this podcast. Okay. I had a pumpkin spice latte.

Nice, so did I. I'm going to get flamed online so badly for liking pumpkin spice lattes. I only have one a year, to be fair. But autumn is that time of year, isn't it?

That transition of summer. And one of the features that I love personally is mushrooms appearing in the woods. I went for a walk in the woods at the weekend. There's just so many different types of mushroom popping up out of the ground, out of trees.

And so we thought it was a great time of year to actually do an episode looking at mushrooms. And this week, we're going to be looking at two aspects of mushrooms. The first is the actual things that pop up out of the ground and their association with toxicity. But also we thought we'd take a look at some newer mushroom products that have been appearing on the market, claiming to contain mushroom.

Before we dive into today's episode, if you want to stay up to date with our content, you can find us on Instagram at [@the_tox_lab](#). We also have a LinkedIn page, which we're fairly active on, so go check us out over there. And for those of you who don't use social media but want to get in touch with episode suggestions or comments about our episodes, you can email us at thetoxlab@gmail.com. So let's jump right in, Rebecca, to our first paper looking at mushroom poisonings in the UK.

So this first paper looks at telephone inquiries to the National Poison Information Service here in the UK involving mushroom exposures between the 1st of January, 2013 and the 31st of December, 2022. In this study, mushrooms that were co-ingested with other substances were excluded and they also had information on where mycologists had been consulted to tentatively identify the mushrooms to determine whether it was likely that they were highly toxic or not when patients presented with complex or moderate to severe clinical features. So over this time period, there were 1,285 mushroom-only ingestion inquiries relating to 1,195 patients.

And there were significantly higher numbers of inquiries from June to November, so as the mushrooms are obviously appearing out in nature than winter and spring where you don't really see many mushrooms out. 690 of these schools were from hospitals, 339 were from the NHS 111 service and 154 were from GPs or other primary care sources. And some other sources included ambulance staff, schools, urgent care, community pharmacists, police and support services. And this is a line for professionals, isn't it?

So this isn't a line that the general public are going to phone, which is why there's overwhelmingly professionals making these calls. 50% of the patients who presented were below the age of nine with

39% of them being below the age of five years old and the majority of people were male. 68% of individuals were exposed at home, but public areas and schools were other popular locations for exposure to mushrooms. When breaking down how the ingestion occurred, 84% of exposures were unintentional with 5% resulting from recreational misuse, 3% were intentional, 3% were adverse reactions with two cases due to deliberate intentional self-harm.

So recreational use, presumably that's people looking for psychedelic mushrooms, hallucinogenic mushrooms. Intentional, intentional looking for poisonous mushrooms or intentional looking for mushrooms as opposed to accidentally eating mushrooms. This is my understanding that the unintentional exposures are most likely the children who've picked up mushrooms and put them in the mouth and don't realize what they're doing. And those that are intentional, I think are probably those who've gone foraging from mushrooms, thinking they're picking edible mushrooms and are that accidentally pick something else and then present the symptoms.

That makes sense. 63 different species of mushroom were reported out of 1,208 ingestions with 98% of these being single agent ingestion. So one mushroom, six patients ingested two separate mushroom species, two patients ingested three different mushroom species and one patient ingested four types of mushroom. 80% of these ingestions were recorded as mushroom fungus or toadstool not known.

So where the mushroom that they'd ingested couldn't be identified. Of those that were known, magic mushrooms were the most frequently reported followed by death cap mushrooms, yellow staners and shiitake mushrooms. So in 50 of these cases, a mycologist was asked to identify the species of mushroom that was involved. Out of these 50 cases, 13 of these involved children under the age of five.

In seven of these cases, some mycologist was unavailable at the time to consult on these cases. And in 10 of them, they were unable to positively ID a species due to the quality of the photos that they'd received. Of the remaining 27 were identified as unlikely to be highly toxic and six were identified as potentially being highly toxic. So out of all the patients that were included in the study, 697 of them were asymptomatic on presentation.

Of the other patients, 31% had a minor poison severity score, 8.3% were classified as moderate and 12 individuals were classified as severe. And all those that were classified as severe were adults and no fatalities were reported. In terms of reported symptoms, 37% reported vomiting with abdominal pain, diarrhea, and nausea also being frequently reported symptoms. Other symptoms included abnormal hepatic and kidney function, dizziness, fever, headache, dilated pupils, and hallucinations, agitation, and anxiety.

Magic mushroom exposure seemed to be responsible for the majority of the cardiac and neurological features which are common effects of psilocybin ingestion. And in terms of treatment for these patients, 57% involved monitoring, supportive care was also a very popular treatment option. And other treatments included the use of activated charcoal, acetyl cysteine, benzoyl pillicillin, and IV fluids. So massive 10-year period of study, large number of mushroom exposures.

Most of the time, no effect at all. In a minority of time, there were some symptoms, including some severe symptoms requiring hospitalization. And a vast majority of these actually were accidental ingestion in children followed by adults picking magic mushrooms, which I guess is to be expected. So the seasonal trend was probably unsurprising, wasn't it?

You're much more likely to have a mushroom poisoning in the autumn when the mushrooms are everywhere to be picked and eaten by children and others. What was interesting was they didn't observe a trend over the 10-year period. So it doesn't look like poisonings, or cause to the poison

center, rather, have increased or decreased over that period, which I thought was quite interesting. It's been quite constant.

I did wonder if there might have been a Google Lens effect at some point in this study, because during this study period, suddenly everybody's got phones in their pocket that couldn't Google ID mushrooms. And I think that could go either two ways, either people are misidentifying things because Google Lens is bad, or able to identify things better and not pick poisonous mushrooms. Yeah, it's hard to know which way that will go. But it doesn't look like this data suggests one way or the other, so can't really answer that question.

Looking at the symptoms, we covered death cap mushrooms a few weeks ago now, didn't we, or months ago? Yeah, back in episode 38, we covered death cap mushrooms in the whole episode. So go check that out if you want some more details on death caps specifically. And death caps being one of the deadliest mushrooms.

Whereas a lot of the other inedible toxic mushrooms cause mostly GI upset. And that's what we're seeing in this data. We're seeing a lot of vomiting, abdominal pain, diarrhea, nausea, and then in the rarer cases, liver function, kidney function. We'll dive a little bit into some of the toxicity mechanisms in a moment, because I think some of them are really quite interesting.

But first I wanted to look at some of the names, because some of these names of the mushrooms are incredible, aren't they? They're just amazing, I really love it. What's your favorite on this list? Ooh, I mean, it's the toss up between King Alfred's cake and Shaggy Paracol.

I think are the two most entertaining names on that list. They're both pretty good, aren't they? I can't see it listed on this list of mushrooms in the paper, but my favorite mushroom name is the sycana. Ooh.

Because it does exactly what it says on the tin, causes this GI upset, vomiting, diarrhea. I think one of the other fascinating things about this paper was how few of these cases they were able to actually ID the mushroom, and how sometimes they couldn't even get hold of somebody that could ID the mushroom. So you've got these expert mycologists, who are clearly few and far between, because they couldn't get hold of them when they needed them, and yet people are going out picking mushrooms willy-nilly without any formal training, and the expert mycologists can't ID them.

So it did make me realize just how hard it can be actually telling some of these mushrooms apart. And so many of them look so similar at a glance, like you can have one that's okay to eat, and then one that's really poisonous, and there's a very subtle difference in their visual appearance. Yeah, and that really is the risk, isn't it? With death caps, that was a big one.

So let's quickly look a bit at some of the individual mushrooms and the toxicity. We talked, as we say, about death caps before, so we're not going to go over death caps again. I do want to look at Flyer Garrick. This is my favorite, favorite mushroom.

Classic, iconic, red with white spots. I think it's my favorite. I've had several pairs of earrings that match that, so. And that featured relatively heavily in the list.

It was, what, number five on the list in terms of commonly reported mushroom species poisonings. And these are really interesting, because they contain a few different compounds. And the main one really being this compound muscimol. A muscimol is a GABA-A agonist.

And what's interesting about Flyer Garrick and muscimol is its association with fairy tales and witchcraft does come from the fact that it is actually psychoactive. So unlike a lot of the mushrooms, which will cause GI distress, this will cause GI distress. It can cause altered perceptions and

hallucinations. It's not a psychedelic mushroom, like classic magic mushrooms.

It doesn't contain psilocybin, but it does have this mind-bending effect. But it can also cause muscle-switching, alterations in blood pressure, diarrhea, and, you know, at high doses, it can be fatally poisonous. And I want to talk a little bit about its name, because this is a fun mushroom fact. In fact, we've got some fun mushroom and pharmacology facts that come from Flyer Garrick.

So it's called Flyer Garrick because it was historically used as a fly trap by putting a little piece of it in a saucer of milk, and flies would come and drink the milk and then die. Oh, okay. And its Latin name is *Amantia muscaria*. And *muscaria* is Latin for fly-like, or of the fly, because of its fly trap use.

Right, now this is where it gets really interesting because we were talking about muscimol, which is the compound isolated that's toxic in these mushrooms. There is another compound called muscarine, which was also identified in low concentrations in Flyer Garrick. It's actually the toxic component of a number of other mushrooms. Oh, okay.

Muscarine mimics the effect of acetylcholine and binds to a subtype of acetylcholine receptors, which are known as muscarinic acetylcholine receptors. We were talking about these last week when we were talking about clozapine. They all come from the fact that Flyer Garrick was used as a fly trap, which I think is really interesting. That is really cool.

I wanna look at some of the other toxic compounds as well. We talked about muscarine. Muscarine is found in a lot of mushrooms and that can cause toxic effects at high concentrations. As I say, it acts like acetylcholine, so it can cause that cholinergic syndrome.

One particular one I did want to look at is a mushroom, which is called the brown roll rim, which sounds more like a bakery product than a mushroom. It does actually, yeah. And these are really interesting mushrooms because it was believed that these were edible because you can eat these one day and be okay, and then you can eat them again and be okay. And then you can eat them again.

And one day, you're not okay. And I don't think we've actually figured out quite what's in them, but something in them seems to prime the immune system. And so repeated exposure to these mushrooms leads to this autoimmune hemolytic anemia. Oh, wow.

Where your immune system attacks your own bloodstream. But for a long time, because people weren't getting acutely unwell after their first exposure, these mushrooms were believed to be edible. That is interesting. So all in all, I really enjoyed reading this paper.

I found it was really quite insightful as to the sort of mushrooms that lead to poisoning. And in general, how most of the time it's okay, occasionally it's not. Nonetheless, don't take a chance. Don't go eating mushrooms unless you're absolutely 100% sure you know what they are.

Considering mycologists couldn't ID them half the time, I'm probably not gonna take those chances. I do wanna give a big shout out to the NPIS National Poisons Information Service. They do a great job of keeping people safe so that they don't end up with Rebecca and myself. So why don't we now move on and look at a very different aspect of mushrooms.

And that is trends in mushroom products. And in particular, we're looking at psychedelic mushroom products, aren't we? There's a lot of mushroom products out there. We haven't really talked about this thus far, but they've become a big thing, haven't they?

Lions, Maine. Specifically, we're gonna be looking at products which have been sold as magic mushroom gummies or magic mushroom chocolates. Yeah, so this next paper looks at 12 magic mushroom containing products purchased at retail shops in Portland, Oregon. And this included 11

different gummies and one brand of chocolate.

After an extraction process, samples were tested using LCMS for silosine and psilocybin. GCMS issued a screen for a range of other substances and this was confirmed and other substances identified using high resolution mass spec or tandem mass spec. So five of these gummies and the chocolate disclosed active ingredients on the product label. So I'm not gonna go into detail of every single one of them, but a couple of the highlights.

So one of them stated that it contained a hundred milligrams of psilocybin, but none was detected in the sample. Another stated it contained lion's mane extract, Rishi mushroom extract, and a proprietary microdose nootropic blend that contained cannabinoids instead. So both of these are shocking, aren't they? Lion's mane is a mushroom that is not believed to be psychoactive in any way, shape or form.

It's got some really interesting properties. It may help improve neuronal growth. There's a lot of really exciting research looking at lion's mane, but it's not psychoactive. And here we've got a product claiming to contain lion's mane, actually contained cannabinoids, which is a real shock if you think you're buying a wellness product.

Conversely, the other one that claimed it contained a hundred milligrams of psilocybin, which is absolutely massive, by the way. You know, a moderate dose might be 10 to 20 milligrams. So a hundred milligrams of psilocybin is huge, actually contain nothing. So another one of these gummies didn't stay any active ingredients on the label, but further testing revealed it contained synthetic psychoactive tryptamines, including miprosetin, and four hydroxy diethyl tryptamine and their isomers.

And these are not naturally occurring compounds, are they? They're synthetic tryptamine, psychedelics. There's limited data available. There's a few trip reports on Aeroweed where people have taken these compounds deliberately, but these are not tried and tested compounds with no safety profiles or anything like that.

In the chocolate sample, they tested, stated it contained lion's mane and reishi mushrooms, but instead contained psilocin, which again is a bit of a shock if you're thinking you're buying lion's mane chocolate, and then you're getting magic mushrooms. For sure, for sure. And crucially here, it's psilocin rather than psilocybin. So hallucinogenic mushrooms contain psilocybin, which is converted to psilocin in the body, psilocin being the active.

This just contains psilocin. So this doesn't actually probably contain mushrooms, right? It's just lab-made psilocin that's been added to chocolate. Yeah, and this is the case for two of the other gummies as well that contain psilocin, but no psilocybin or any biosynthetic precursors.

So it did suggest that they weren't mushrooms in the chocolate. It was synthetic psilocin that had been added later. So they haven't even seen a mushroom. No.

It's really concerning, isn't it? One of these gummies did contain an extract of kava, which is used for its anxiolytic and hallucinogenic properties, but it's also been linked to hepatotoxicity. So it could potentially be dangerous as well. kava's a Phygian root. As you say, it's got calming properties and can be hallucinogenic at high doses.

This gummy actually contained a few different kava compounds, didn't it? I believe so, yeah. That possibly does indicate it did actually have some kava in it, but not mushrooms like it was claiming. It's really concerning, isn't it?

You've got these products that all advertised to claim one thing or another, and in fact, virtually all of them contained something very different to what was on the label. And it does seem to be a bit of an

unregulated market. So Oregon, where this data was collected, has decriminalized a lot of minor possession of a lot of compounds, including psilocybin. And there seems to have then been this rise in this sort of unregulated market.

I'm not sure it is strictly legal, but it seems to be sort of falling down the law enforcement cracks a little bit. And certainly there seems to be a lot of open sale of these compounds. We've talked a lot before, haven't we, about the open sale of mitragynine compounds and delta-8. This seems to be an extension of that, really, these products that are exploiting a little loophole in the law in certain markets.

But it is a concern to users. They go in and they think they're buying a wellness gummy, and in fact, they're getting a load of cannabinoids or a unlicensed, untested, synthetic tryptamine. So another mushroom-related story that I spotted in the news in the last few months was the Australian cases related to, was it Uncle Frog's? Yeah.

Uncle Frog's gummies. Do you want to take us through that, Rebecca? So a safety notice from New South Wales Health stated that since April 2024, five patients were presented to New South Wales Health emergency departments experiencing unexpected toxicity after consuming Uncle Frog's mushroom gummies, including the Cordyceps mushroom gummies and the Lion's Mane mushroom gummies. The contents list included these non-psychoactive mushrooms and hemp-derived extract, and HHC or CBD was also listed on some of the packaging.

The symptoms from these cases included decreased consciousness, involuntary movements, including recurrent twitching, which has been described as seizure-like, hallucinations, anxiety, palpitations, dizziness, nausea, and vomiting, and all cases recovered fully and were discharged from hospital. So again, these are wellness gummies containing non-psychoactive mushrooms. Although, if you look in the small print, some of them actually say they contain CBD and, crucially, HHC, hexahydrocannabinol, which is, we've talked about it before, haven't we, a semi-synthetic cannabinoid that is psychoactive.

So even then, that's a little bit worrying that the broader marketing is non-psychoactive wellness mushrooms. And then, oh, in small print, by the way, contains HHC. I think this is a nice little notice to kind of highlight the importance of including supplements and stuff when you're taking a history and people present to emergency departments with weird symptoms because they might consider it completely unrelated to how they're presenting, but there might be something in there that does explain how they've presented. Yeah, that's really true.

How many people feel rough, go to the doctor, especially if they think they're taking a wellness gummy, containing non-psychoactive mushrooms, may not put two and two together. So there was a recall notice on these products and some were labeled as containing HHC, some weren't. And I don't think the actual cause has been identified, has it? They were able to link a lot of these presentations with this particular brand of gummy.

I don't think any testing I did what might have been causing this and whether this was a contamination or whether this was a deliberate inclusion of some questionable ingredients. So two very, very different implications of mushrooms here. The first being the naturally occurring kind that children put in their mouths and the other being, well, in some cases, sold as psychedelic mushroom products. But actually a lot of the time, not.

A lot of the time, these were these wellness products. And as we said, they are everywhere. Marx and Spencer are now selling Lion's Mane's Movie. And I'm not suggesting that these are containing hidden psychoactive ingredients at all.

I'm sure there's a lot of legitimate suppliers out there providing very high quality wellness mushroom products. But it is everywhere. I had a Lion's Mane hot chocolate at the weekend. And how did it make

you feel?

Hopefully it didn't make you feel like anything because it's not supposed to be psychoactive. It didn't. But it is concerning, isn't it? In this era of wellness and supplementation, and some of it, as I say, you know, Lion's Mane, the research is really encouraging.

I can see why people may want to try taking a gummy that might help their memory or help them relax. But it needs to contain what it says on the label to make an informed decision. And if you're buying products that say they contain one thing and actually contain something else, or you're buying a wellness gummy that gives you hallucinations and paranoia, that's clearly not a good thing to be doing. I'm wondering where the mushroom trend is going to end, where it's going to go.

Yeah, it'll be interesting. I feel like it's becoming, I should say, more mainstream. Like I've seen it a lot this year in places like Marks and Spencers and things. So whether other people will catch on and then it will go away, I don't know.

So Rebecca, if you had to sum up mushrooms in one word, what would you pick? Well, that's really hard. I don't know, the first word that comes to mind is all to me, which I don't think is actually a word. I was just thinking that it's not possible to give them one word, is it?

No. Food, poison, hipster wellness product, recreational drug. Autumn decor. Autumn decor.

You decorate your house with mushrooms. No, but I've definitely got mushroom printed bedding, so. That makes more sense. And so mushrooms really are incredibly versatile, aren't they?

They really are. I do hope you've enjoyed listening to us this week, chat about mushrooms. Do check us out on social media, give us a like, share, that would be amazing. We really appreciate you all tuning in and listening to us.

Ramble away about autumn. Hope you've all had an amazing week, and we'll see you next time, bye.