Mushroom Toxicosis in Dogs

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Mushroom species are difficult to identify, so treatment—especially in dogs that scavenge—is based on the presumption that the mushroom is toxic.

You have asked…

How should mushroom toxicosis be treated in dogs when the mushroom can rarely be identified?

The expert says…

There are thousands of mushroom species in North America, but fewer than 100 are poisonous.[1] Mushroom species can be difficult to identify, so treatment, especially in dogs that scavenge, is based on the presumption that the mushroom is toxic.[2] The following focuses on types of mushrooms that can result in poisoning in dogs (**Tables 1** and **2**, next page).

Hepatotoxic Cyclopeptides

The most dangerous type of mushrooms contain hepatotoxic cyclopeptides, including amatoxins (most toxic), phallotoxins, and virotoxins. These include *Amanita phalloides* (death cap or death angel), *A ocreata* (angel of death), *Galerina* spp, and *Lepiota* spp. This class of mushroom results in 95% of mushroom-related fatalities in humans and the most fatalities worldwide.[5] When ingested, amatoxins are taken up by hepatocytes via the sodium-dependent transport system and inhibit nuclear RNA polymerase II, which results in decreased protein synthesis and secondary cell death.[5] Three phases of toxicosis are seen: severe GI signs (hypersalivation, vomiting, diarrhea, abdominal pain) within 6–24 hours; a false recovery period (12–24 hours); and a hepatorenal phase (36–72 hours postexposure).[5,6] Kidney failure can develop as a result of proximal and distal tubular necrosis several days later.[5]

Along with appropriate clinicopathologic monitoring and symptomatic supportive care, treatment includes early decontamination (emesis induction if appropriate, followed by multiple doses of activated charcoal); fluid therapy (crystalloids, colloids); GI support (antiemetics, antacids); treatment for coagulopathy if indicated (vitamin K1 therapy, plasma transfusions); treatment for hepatic encephalopathy (lactulose, neomycin, anticonvulsants); hepatoprotectants (silibinin, *S*-adenosyl methionine, *N*-acetylcysteine). Peritoneal dialysis[5] and parenteral penicillin G benzathine[2,3] have also been reported to yield sucessful results in humans. Acute hepatic failure is more commonly seen in dogs than acute kidney injury; once signs of severe organ injury develop, prognosis is poor to grave.

Mushroom Toxicity Cases

In the past 10 years, the ASPCA Animal Poison Control Center had almost 5000 mushroom cases reported, involving 4561 dogs, 77 cats, 7 birds, 7 goats, 3 ferrets, 3 rabbits, 1 marsupial, and 1 pig.[3] Death was reported in 23 animals (0.49%). In the cases where the animal survived, the type of mushroom was unknown at the time of the call (93.3%). In the fatalities, the type of mushroom was unknown 91% of the time.

Top mushrooms identified were:

- *Psilocybe* spp (2.6%)
- *Agaricus bisporus* (1.1%)
- *Amanita* spp (0.5%)
- *Inocybe* spp (0.5%)
- *Amanita muscaria* (0.4%)

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Muscarinic Agents

Inocybe spp and *Clitocybe* spp mushrooms contain muscarine, a muscarinic-receptor agonist that results in postganglionic parasympathomimetic effects.[4] Clinical signs can be seen within 2 hours and include SLUDGE (salivation, lacrimation, urination, defecation, GI upset, emesis) and neurologic signs.[4] Other clinical signs include increased genitourinary muscle tone, miosis, bradycardia, bronchoconstriction, wheezing, dyspnea, vomiting, lethargy, and collapse.[4,5]

Table 1. Toxicologic Classification of Toxic Mushrooms[1,3-5]

Toxin Type	*Species*	*Layman's Name*	*Mechanism of Action / Method of Toxicity*
Hepatotoxic cyclopeptides	■ *Amanita* spp (*A phalloides, A ocreata*) ■ *Galerina* spp ■ *Lepiota* spp	■ Death cap ■ Death angel ■ Destroying angel ■ Deadly agaric	Amanitins inhibit nuclear RNA polymerase II, resulting in decreased protein synthesis and secondary cell death. Cells with rapid replication are most affected.[4]
Hydrazines (Monomethyl–hydrazines)	■ *Gyromitra* spp	■ False morels	Hydrolyzes gyromitrin to *N*-methyl-*N*-formylhydrazine, which is further metabolized to monomethylhydrazine. Toxicant results in antagonism of pyridoxine (vitamin B_6), a cofactor required for the synthesis of gamma-aminobutyric acid (GABA).[4,5]
Muscarinic agents	■ *Inocybe* spp ■ *Clitocybe* spp		Works at the peripheral nervous system to compete with acetylcholine at the receptor binding sites, resulting in muscarinic cholinergic signs.[4]
Isoxazoles	■ *Amanita pantherina* ■ *Amanita muscaria*		Muscimol and ibotenic acid are GABA agonists and result in psychotropic symptoms.[3-5]
Psilocin & psilocybin	■ *Conocybe* spp ■ *Gymnopilus* spp ■ *Psilocybe* spp ■ *Panaeolus* spp	■ Magic mushrooms ■ Hallucinogenic mushrooms	Psilocybin is dephosphorylated to psilocin, which crosses the blood-brain barrier, acting as an LSD-like compound.[5]
GI irritants	■ *Agaricus* spp ■ *Boletus* spp ■ *Chlorophyllum* spp ■ *Entoloma* spp		Unknown toxic principle. Many toxins in this category are inactivated by cooking.[5]
Orellanine	■ *Cortinarius* spp		Unknown toxic principle that results in acute kidney injury.
Coprine	■ *Coprinopsis atramentaria*		Inhibits aldehyde dehydrogenase, thus inhibiting the conversion of ethanol to acetate. If ethanol is not concurrently ingested, toxicosis does not occur. Toxicosis from this mushroom is unlikely to occur in veterinary medicine.

GABA = gamma-aminobutyric acid, SLUDGE = salivation, lacrimation, urination, defecation, GI upset, emesis

Treatment includes early decontamination (emesis, activated charcoal), fluid therapy, GI support (antiemetics, antidiarrheals), and atropine. Prognosis is fair to good with symptomatic and supportive care.

Isoxazoles

Amanita muscaria (fly agaric) and *A pantherina* (panther cap) contain isoxazole derivatives muscimol and ibotenic acid, which are potent agonists at GABA receptors that inhibit neuronal and glial GABA uptake.[5] These toxins also have psychoactive

Table 2. Medications & Dosage Commonly Used to Treat Mushroom Toxicosis[1-6]

Drug	*Use*	*Dose*
Activated charcoal	Minimizes absorption of the toxicant from the GI tract.	1–5 g/kg PO once. If multiple doses are used, dose at 1–2 g/kg PO q4–6h × 24h
Atropine	Competes with both acetylcholine and muscarine at cholinergic muscarinic receptor sites; used for muscarine mushroom toxicosis.	0.02–2 mg/kg, divided IV and IM
Diazepam	Anticonvulsant	0.25–0.5 mg/kg IV PRN
Maropitant	Antiemetic	1 mg/kg SC or IV (extra-label) q24h
***N*-acetylcysteine**	Hepatoprotectant; used for hepatotoxic cyclopeptides mushroom toxicosis.	140–280 mg/kg IV or PO once, followed by 70 mg/kg IV or PO q6h × 48–72h as needed. *Note:* IV route preferred to prevent decreased absorption when given orally with activated charcoal.
Penicillin G benzathine	Displaces amatoxins from plasma protein-binding sites and reduces update of amanitins into hepatocytes.	1000 mg/kg IV immediately after exposure
Phenobarbital	Anticonvulsant	4–20 mg/kg IV as needed
Plasma (as fresh frozen or frozen)	Used to treat coagulopathy secondary to hepatic injury.	10–20 mL/kg IV if coagulopathic
Pyridoxine	Vitamin B_6; used for hydrazine mushroom toxicosis.	25 mg/kg slow IV over 15–30 min
***S*-adenosylmethionine**	Hepatoprotectant	18–20 mg/kg PO q24h
Silibinin	Hepatoprotectant	50 mg/kg IV, 5h and 24h after *Amanita phalloides* exposure **or** 2–5 mg/kg PO q24h
Vitamin K1 (phytonadione)	Used to treat coagulopathy secondary to Vitamin K-dependent factors inactivated during hepatic injury.	1.0–2.5 mg/kg PO; or, SC q12h if coagulopathic

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properties and act as both CNS depressants and stimulants.[4,5] Clinical signs, which can be seen within 30 minutes to 12 hours of ingestion, include sedation, ataxia, disorientation, miosis, opisthotonus, paresis, paddling, vestibular signs, tremors, seizures, respiratory depression, coma, and (rarely) death.[5]

Treatment includes early decontamination if appropriate (emesis and a dose of activated charcoal), fluid therapy, confinement in a quiet area, anxiolytics, and anticonvulsants. Respiratory monitoring and symptomatic supportive care is imperative, as CNS depression and concurrent anticonvulsant therapy can potentially result in apnea.

Hydrazines

A less toxic mushroom is the *Gyromitra* spp (false morels), which contains hydrazines. Limited information is available about the toxicokinetics of these mushrooms, but the toxin antagonizes pyridoxine (vitamin B_6), a cofactor required for the synthesis of GABA.[4] Clinical signs are typically seen within 6–8 hours of ingestion, and are generally limited to gastrointestinal signs.[4] Rarely, CNS signs (lethargy, seizures, coma) can be seen; with extreme poisonings, hepatic injury has been reported in humans.[4]

Treatment includes early decontamination, fluid therapy, and antiemetics. If seizures develop, pyridoxine can be used along with diazepam.[6] The prognosis is good to excellent with supportive care in most cases.

Gastrointestinal Irritants

Numerous mushrooms (eg, *Agaricus* spp, *Boletus* spp, *Entoloma* spp) are GI irritants but are rarely life-threatening when ingested.[5] Clinical signs can be seen in several hours, and generally resolve within 1–2 days.[5] Treatment typically is not necessary as the signs are self-limiting. With more severe clinical signs, treatment may include fluid therapy and GI support (antiemetics, antidiarrheals).

Psilocin & Psilocybin

Hallucinogenic mushrooms such as *Psilocybe* spp, *Conocybe* spp, *Gymnopilus* spp, and *Panaeolus* spp contain psilocybin and/or psilocin. Psilocybin is dephosphorylated to psilocin, which crosses the blood-brain-barrier, acting as an LSD (lysergic acid diethylamide)-like compound.[5] Clinical signs can develop within 30 minutes to 4 hours in dogs and include anxiety, dysphoria, weakness, mydriasis, ataxia, abnormal mentation, visual hallucinations, tachycardia, howling, aggression, nystagmus, hyperreflexia, hypertension, hyperthermia, and seizures.[4,5] This type of mushroom ingestion is typically not life-threatening. Treatment includes early decontamination, anxiolytics or sedation, symptomatic supportive care, and rarely, cooling measures and anticonvulsants. The prognosis for this type of mushroom is good to excellent with symptomatic supportive care.

Conclusion

Although rapid identification of mushrooms would be ideal, this is not commonly the case with the emergent dog presenting for mushroom toxicosis. Veterinarians should be aware of the major classes of toxic mushrooms, along with toxicologic classification, methods of toxicity, clinical signs, and treatment. While fatalities are rare, treatment should be aimed at aggressive decontamination and therapy. Typically, hospitalization for 24 hours is warranted. If liver and renal function is normal at 24 hours, patients can be discharged on 1–2 weeks of *S*-adenosylmethionine. Rechecking a biochemistry panel at 48 hours after discharge is recommended. Ultimately, the prognosis for the majority of mushroom toxicities in dogs is fair to good. ■ cb

References

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GABA = gamma-aminobutyric acid