CLINICAL IMAGES

Mistaken Mushroom Poisonings

Report of a Case*

A 38-year-old man in prior excellent health presented to the emergency department (ED) with severe nausea and vomiting 4 hours after consuming homemade soup containing parts of 4 wild mushrooms he had picked that day (Figure 1). He described the mushrooms as having straight 4-inch stems (stipes) and bright white caps. His vital signs were unremarkable. Supportive therapy with antiemetics and intravenous (IV) fluids was initiated. Baseline laboratory studies included serum

blood urea nitrogen (BUN), 10 mg/dL (3.6 mmol/L), and creatinine, 1.0 mg/dL (88.4 μ mol/L). His complete blood count, electrolytes, and hepatic transaminases were within normal limits. Because his gastrointestinal symptoms resolved with supportive care and his laboratory studies remained normal, he was discharged from the ED after 8 hours of observation. Five days later, he was readmitted to the ED with a history of anorexia and 8 hours of anuria.

What is your diagnosis?

How would you manage this case?

Figure 1. The mushrooms picked and consumed by the patient. Source: Wikimedia Commons (public domain). Photographer: Sava Krstic.

Diagnosis

The diagnosis was *Amanita smithiana* mushroom poisoning with reversible acute renal failure after the misidentification (and ingestion) of nephrotoxic *A smithiana* mushrooms (Figure 1) mistaken for look-alike edible North American matsutake or pine mushrooms, *Tricholoma magnivalere*.

The nephrotoxic *A smithiana*, or Smith's *Amanita* (Figure 1), is often mistaken for the edible and highly sought after North American matsutake or pine mushroom, *T magnivalere*, a frequent export to Japan where it rivals the Asian matsutake mushroom, *T matsutake*, in popularity. Accidental ingestion of *A smithiana* will cause gastrointestinal toxicity within 6 hours followed by acute renal failure within 2 to 6 days.

After the diagnosis has been made, the laboratory biomarkers of renal function should be reassessed, and preparations for temporary hemodialysis should be instituted.

Follow-Up of the Reported Case

On readmission to the ED, the patient's BUN was 77 mg/dL (27.5 mmol/L), and his creatinine was 14 mg/dL (1237.6 μ mol/L). A dialysis catheter was inserted for rapid hemodialysis for acute renal failure. After 12 days of inpatient dialysis, his BUN and creatinine returned to normal ranges, and he was discharged from the hospital. His dialysis catheter was removed in the nephrology clinic 4 days later.

Introduction

Mushroom poisonings are common, but rarely serious or fatal.^{1–3} There were more than 25,000 reports of mushroom poisonings worldwide from 1951 to 2002.³ The greatest risk factor for mushroom poisoning is the misidentification of a poisonous species as edible by amateur mushroom hunters and immigrants.^{1–3} There are more than 5000 species of mushrooms. Greater than 2000 species are edible. Only about 100 species have been confirmed as poisonous.^{1–3}

In a retrospective epidemiological analysis of mushroom poisonings during a 50-year study period, Diaz³ described the following results. Reports of fatal and nonfatal mushroom poisonings increased significantly every decade. Some mushrooms formerly described as edible were reclassified later as poisonous. Several new species of poisonous mushrooms were described in the 1990s, including *A smithiana*, *Amanita proxima*, and *Tricholoma equestre*. The most lethal mushroom poisonings continued to follow ingestions of hepatotoxic amanitin-containing mushrooms. These findings were confirmed in subsequent investigations.^{1,2,4}

The edible mushroom trade is a \$3 billion per year international industry that is projected to grow to \$5 billion a year by 2019.⁵ Europe accounts for the largest market share, followed by China and the United States.⁵ The major mushroom-producing nations export tons of mushrooms annually to nations that depend on mushrooms for many traditional, national dishes. For example, the North American matsutake mushroom, *T magnivalere*, now rivals the Asian matsutake mushroom, *Tricholoma matsutake*, as a popular Japanese food import. As a result, there is an increasing risk today of mistaking look-alike poisonous mushroom species as highly prized, edible species either for local and regional sales or for export.

Recently, mushroom gourmets in the Scandinavian countries developed local cooking practices that can partially detoxify some poisonous species by parboiling them, such as false morels, *Gyromitra esculenta*, which closely resemble the edible and highly desirable, common morels, *Morchella esculenta*, in appearance and taste. A grocery store in Helsinki sells packaged, poisonous false morels, *G esculenta*, that rival the more expensive common morels, and could sicken unsuspecting consumers who are unaware of proper preparation procedures (Figure 2).

Mistaken Mushrooms

In the United States and Europe, the most frequently misidentified look-alike mushroom pairs today include 1) either the poisonous *A smithiana* (Figure 1) in the United States for the North American matsutake, *T magnivalere* (Figure 3), or the poisonous *A proxima* (Figure 4) in Europe for the Asian matsutake, *T matsutake* (Figure 5); 2) the poisonous false morel, *G esculenta* (Figure 6), for the common morel, *M esculenta* (Figure 7), in both the United

Figure 2. Packaged, poisonous false morels, *G esculenta*, are popular sale items at this Helsinki grocery and rival the more expensive common morels in sales. Source: Wikimedia Commons (public domain). Photographer: Ilmari Karonen.

Figure 3. The North American matsutake mushroom, *T magnivalere*, is closely related to the East Asian matsutake mushroom, *T matsutake*. North American matsutakes are frequently shipped fresh by air from the US and Canadian Pacific Northwest to Japan where demand and price for imported matsutakes are very high. Source: Wikimedia Commons (public domain). Photographer: Ryane Snow.

States and Europe; and 3) the poisonous jack-o'-lantern mushrooms in Europe, *Omphalotus olearius* (Figure 8), and in the United States, *Omphalotus illudens* (Figure 9), for prized golden chanterelles, *Cantharellus cibarius* (Figure 10), worldwide.³

Figure 4. The nephrotoxic *A proxima* is a commonly encountered white mushroom throughout the European Mediterranean regions and has been mistaken for edible *Amanita* species in France, such as *Amanita ovoidea*, and also closely resembles the North American matsutake, *T magnivalere*, and the Asian matsutake, *T matsutake*. Source: Wikimedia Commons (public domain). Photographer: James Baker.

Figure 5. The edible Asian matsutake, *T matsutake*, grows throughout the Eastern Asian mixed pine and oak forests. The edible North American matsutake, *T magnivalere*, is exported from the Canadian and US Pacific Northwest to China and Japan to supplement sales of the Asian matsutake, a key ingredient in many traditional, national dishes. Source: Wikimedia Commons (public domain). Photographer: S. Caspar.

AMANITA SMITHIANA AND AMANITA PROXIMA

If consumed instead of matsutake mushrooms, *A smithiana* (Figure 1) or *A proxima* (Figure 4) ingestions can cause a combination of initial gastrointestinal toxicity within 6 to 12 hours and later acute renal toxicity within 2 to 6 days.⁶⁻⁹ Poisoned patients may present in an anuric or oliguric condition about 1 week after ingestion, and manifest acute renal insufficiency with rising serum BUN and creatinine levels.⁶⁻⁹ Treatment of suspected *A smithiana* or *A proxima* poisoning is primarily supportive.

Although not without risks, some authorities continue to recommend gastric lavage in cases presenting less than 6 hours after ingestion to obtain undigested mushroom parts and spores for expert identification by mycologists.¹⁰ Suspect meals and vomitus should also be preserved for later expert identification of mushroom parts.^{9,10} In cases presenting within less than 6 hours in which samples of suspected poisonous mushrooms from the field, mushroom meals, or recent patient vomitus containing mushroom parts are unavailable, gastric lavage may retrieve enough undigested mushroom parts, such as the gills and their attachment sites, for an expert to differentiate between innocuous mushroom poisonings and the most serious and potentially fatal poisonings by nephrotoxic and hepatotoxic species. Thin-layer chromatography can

Figure 6. The neurotoxic false morel, *Gyromitra esculenta*, with its wrinkled, brain-like cap, resembles the highly prized common or true morel, *Morchella esculenta*. Even when false morels are parboiled to volatilize toxins, the principal toxin, gyromitrin, can induce vomiting and diarrhea within hours, followed by dizziness, headache, and lethargy. Delirium and fatal coma have been reported after 5 to 7 days in severe poisonings. Source: Wikimedia Commons (public domain). Photographer: Severine Meibner.

also confirm the diagnosis by detecting the presence of the nephrotoxin in suspect foods or vomitus.⁸

Activated charcoal administration has not been confirmed to absorb the suspected nephrotoxin, allenic

Figure 7. The common or true morel, *Morchella esculenta*, is among the most highly sought after, edible mushrooms that cannot be grown commercially. It is a widely distributed mushroom throughout North America. Source: Wikimedia Commons (public domain). Photographer: Tommes-Wiki.

Figure 8. The European jack-o'-lantern mushroom, *Olearius*, is a poisonous mushroom with yellow-orange gills and a sweet, apricot scent that contains the potent gastrointestinal toxin, illudin, which can cause cramping abdominal pain with vomiting and diarrhea within 4 to 6 hours of ingestion. The European jack-o'-lantern is closely related to the North American jack-o'-lantern, *O. illudens*, which also contains illudin and can cause the same toxidrome after ingestion. Jack-o'-lantern mushrooms resemble chanterelles in color and sweet smell and can be differentiated from chanterelles by their bioluminescent gills, which glow blue-green at night and account for their common name, jack-o'-lanterns. Source: Wikimedia Commons (public domain). Photographer: Antonio Abbatiello.

Figure 9. The North American jack-o'-lantern mushroom, *O. illudens*, is a poisonous mushroom with yellow-orange gills and a sweet scent that contains the potent gastrointestinal toxin, illudin, which can cause cramping abdominal pain with vomiting and diarrhea within 4 to 6 hours of ingestion. The North American jack-o'-lantern is closely related to the European jack-o'-lantern, *O. olearius*, which also contains illudin and can cause the same toxidrome after ingestion. Jack-o'-lantern mushrooms resemble chanterelles in color and sweet smell and can be differentiated from chanterelles by their bioluminescent gills, which glow blue-green at night and account for their common name, jack-o'-lanterns. Source: Wikimedia Commons (public domain). Photographer: Jason Hollinger.

Figure 10. The golden chanterelle, *C cibarius*, is yellow-orange in color and funnel-shaped, and emits a fruity aroma. Chanterelles are widely distributed worldwide and have been recognized as culinary delicacies for centuries. The jack-o'-lanterns or *Omphalotus* species mushrooms have been mistaken for chanterelles in the United States and Europe and can cause severe, but typically nonfatal, gastrointestinal toxicity, if ingested. Source: Wikimedia Commons (public domain). Photographer: Not identified. Photo identified as "Strobilomyces in a French Wood on 31st October 2004."

norleucine, and is not recommended. Although it has not been recommended, whole bowel irrigation may prove useful in removing undigested mushroom parts that can continue to release nephrotoxins, especially in cases in which gastrointestinal motility has been slowed by prior use of anticholinergics, alcohol, or opioids. Because both the nephrotoxic and the amanitin-containing, hepatotoxic mushrooms exhibit a "honeymoon" or asymptomatic improvement period after recovery from the initial gastrointestinal toxicity, all patients who have ingested unidentified mushrooms should either be observed and monitored as inpatients or asked to return to the ED or for a follow-up visit with a primary-care provider for laboratory monitoring of routine biomarkers of early renal and hepatic dysfunction every 24 hours for 72 to 96 hours after ingestions.⁶⁻⁹

In most cases, definitive treatment of *A smithiana* or *A proxima* poisoning will require hemodialysis until patients recover renal function.⁶⁻⁹ Patients generally recover renal function after 10 to 15 days of inpatient hemodialysis.⁶⁻⁸ Patients with improving renal function may be discharged to outpatient hemodialysis, which may require another 1 to 3 weeks of hemodialysis until normal renal function returns.⁶⁻⁹

THE FALSE MOREL: *GYROMITRA ESCULENTA*

If consumed instead of the common morel, *M esculenta* (Figure 7), ingestion of the false morel, *G esculenta*

(Figure 6), may result in early-onset gastrointestinal toxicity from its principal toxin, gyromitrin, within 4 to 6 hours.³ This subacute onset of gastrointestinal toxicity may, rarely, be followed by escalating neurotoxicity with vertigo, delirium, seizures, stupor, and coma, especially in the elderly and in patients on isoniazid treatment for tuberculosis.⁹ Epileptogenic neurotoxicity results from the activation of gyromitrin by phase 1 hepatic hydrolysis to its primary metabolite, monomethylhydrazine, which, like isoniazid, inhibits pyridoxine, a glutamic acid decarboxylase cofactor, with diminished production of γ -amino butyric acid, a central inhibitory neurotransmitter.⁹ Hepatocellular damage from the formation of free methyl radicals may rarely follow gyromitrin-induced seizures, and is characterized by elevated hepatic transaminases, and hyperglycemia with rebound hypoglycemia.⁹ Unlike hepatic failure that frequently occurs after amanitin-containing mushroom ingestions, fatal fulminant hepatic failure is uncommon after severe gyromitrin poisoning.⁹ The treatment of gyromitrin poisoning includes seizure control with titrated IV doses of benzodiazepines and repeated IV boluses of pyridoxine, 25 mg/kg, a specific monomethylhydrazine antidote.⁹

POISONOUS JACK-O'-LANTERN MUSHROOMS: *OMPHALOTUS OLEARIUS* AND *OMPHALOTUS ILLUDENS*

If consumed instead of chanterelles (Figure 10), ingestions of the poisonous jack-o'-lantern mushrooms, either *O olearius* (Figure 8) or *O illudens* (Figure 9), will result in very early onset (<4 hours) gastrointestinal toxicity from their principal toxin, illudin, with vomiting, severe abdominal cramping, and diarrhea. Treatment is entirely supportive.

Conclusions

As demand for exotic, edible mushrooms that cannot be grown commercially increases worldwide, the misidentification of poisonous species as edible may be expected to increase. Clinicians should consider mushroom poisoning in the evaluation of all patients who may be intoxicated by the ingestions of natural substances. Because information on natural, foodborne exposures is often insufficient and incorrect, clinicians can be guided toward earlier, accurate diagnoses by advanced knowledge of commonly misidentified, look-alike mushroom pairs, especially in severe mushroom poisoning cases in which only advanced care, such as hemodialysis or, potentially, kidney or liver transplantation, may be life-saving.

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*Disclaimer: The case reported in this Clinical Images article is a fictitious one that was developed using similar reported clinical and laboratory findings in 3 prior published case reports of *A smithiana* mushroom poisoning^{6–8}

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