CLINICAL IMAGES

Colorful Mushroom Ingestion

A 3-year-old boy accompanied his parents to a Christmas tree farm to select and harvest the family Christmas tree. While his parents were cutting down their selected tree, the boy crawled beneath an adjacent, taller tree that had a cluster of red mushrooms around its trunk (Figure). The child was attracted to the mushrooms with the brightest colored cap and consumed 3 bites of the cap. The mother removed several bits of mushroom from the child's mouth with finger sweeps and rinsed out the child's mouth with bottled water. The child did not vomit or manifest any distress. The father took a picture of the mushroom

cluster with his smartphone. On the ride home, the child fell asleep approximately 1 hour after eating the mushroom, awakened 30 minutes later, and became very excited, hyperactive, and inconsolable. The mother called their pediatrician on the father's smartphone and attached the image of the mushroom. The pediatrician instructed the couple not to give the child anything to eat or drink and to proceed to the closest emergency department immediately.

What was the diagnosis? How would you treat this patient?

Figure. A cluster of red-capped mushrooms is observed in all stages of its growth and development beneath a coniferous tree. Photographer: JH Diaz. Source: Author's personal collection.

Note that, although fictitious, this case is based on the author's real life experiences observing children at Christmas tree farms.

DIAGNOSIS

Amanita muscaria mushroom poisoning.

Management: The child arrived at the emergency department 120 minutes after consuming 3 bites of the cap of a mature *A muscaria* mushroom as identified by its image and confirmed by a consulting expert. On physical examination, vital signs were normal, but the child exhibited hyperkinetic behavior with myoclonic twitching in the lower extremities. An intravenous line was inserted for maintenance fluid therapy with normal saline in 5% dextrose, and a single dose of midazolam 0.1 mg/kg was administered intravenously. The hyperactivity resolved, and the child went to sleep. All vital signs, including transcutaneous oxygen saturation, remained within normal limits. After 4 hours, the child awakened in a confused state. An additional intravenous dose of midazolam 0.025 mg/kg was administered. After 12 hours of observation in the emergency department, the child was discharged home with his parents for follow-up with their pediatrician later that day.

Discussion

A muscaria, the fly agaric, typifies the iconic image of hallucinogenic mushrooms both in legend and in literature, as in Lewis Carroll's *Alice in Wonderland* (1865) (Figure). Known as the bug or fly mushroom in antiquity, pieces of the mushroom's cap were sprinkled into milk to make an insecticide for flies.¹ In 1753, Carl Linnaeus, the father of taxonomy, described the mushroom in his *Species Planetarum*, Volume 2, and named the mushroom *Agaricus muscarius*, from the Latin *musca*, or fly.¹

A muscaria has been consumed by cultures worldwide for its psychedelic effects after being parboiled to reduce the potency of its major water soluble neurotoxins, ibotenic acid and muscimol.² *A muscaria* has also been consumed in larger amounts with significant neurotoxicity after being misidentified as the edible *Amanita caesarea*.³ With a bright red to reddish-orange cap, *A muscaria* also attracts children. Ingestion of even small bites of the cap has caused severe neurotoxicity with respiratory arrest.⁴ Fatalities are rare but possible, especially in children without immediate access to intensive care.⁴

Taxonomy, distribution, description, and ecology

A muscaria is a psychoactive basidiomycete mushroom that exhibits symbiotic relationships with many coniferous and deciduous trees throughout the Northern Hemisphere. It was introduced into the Southern

Hemisphere in shipments of birch and pine seedlings. *A muscaria* is a member of the family Amanitaceae, which contains many poisonous mushrooms, such as *A phalloides*, as well as many edible mushrooms, such as *A caesarea*. There are 7 varieties of *A muscaria* distributed regionally, but the most common and universally recognized variety is *A muscaria* var. *muscaria* with a large red to red-orange cap sprinkled with white patches, the remnants of the universal veil that enclosed the developing mushroom button (Figure).

The mature mushroom has a bulbous base and a thick, white stem with a prominent ring or annulus, the remnants of the partial veil that enclosed the developing free gills. The mushrooms are frequently found in clusters or fairy rings in all stages of growth and development, from emerging buttons to decaying elderly adults, in the shady understories of coniferous and deciduous forests (Figure). The shapes and colors of each growth stage are distinctive. They include pinkish egg-shaped to globular buttons erupting from the soil; parasol-shaped bright red to red-orange mature mushrooms with tops sprinkled with white warts; and less colorful and yellowed aged mushrooms with fully extended flat, platelike caps with fewer white warts or flecks on top, weathered away by rainfall (Figure).

Toxicology and toxicity in humans

A muscaria mushrooms contain the isoxazole compounds ibotenic acid, muscimol, and muscazone as well as other toxins, such as the cholinergic agonist, muscarine.³ Muscimol, a GABA_A and GABA_B receptor agonist, is the major psychoactive neurotoxin in *A muscaria*. Up to 20% of ibotenic acid, an N-methyl-D-aspartate glutamate receptor agonist also present in the mushroom, is converted by decarboxylation to muscimol after drying or ingestion. Although all parts of the mushroom contain toxins, both neurotoxins are concentrated in the mushroom caps. Poisoning after ingestion of *A muscaria* has occurred in 3 groups of high-risk patients: 1) young adults experimenting with natural psychoactive substances; 2) mushroom gatherers who mistake *A muscaria* for edible *A caesarea*; and 3) young children attracted to colorful mushrooms.

Poisoning in adults is typically psychoactive with auditory and visual hallucinations beginning 30 to 90 minutes after ingestion, peaking in 3 to 4 hours, and resolving within 12 to 24 hours.² Satora et al reported a series of 5 young adults (age range: 18–21 years) who had consumed dried *A muscaria* caps for their hallucinogenic effects.² Auditory and visual hallucinations occurred in 4 patients and resolved within 12 hours.² An 18-year-old girl did not hallucinate but became unconscious overnight and was observed in an

emergency department after regaining consciousness the next morning.² All 5 patients recovered completely without sequelae.²

Brvar et al reported more serious neurotoxic reactions in a 48-year-old man who consumed a meal of cooked *A muscaria* mushrooms that he had mistaken for *A caesarea* mushrooms.³ The patient vomited 30 minutes after the meal, then fell asleep and was discovered comatose 4 hours later after an apparent seizure.³ A computed tomography scan of the brain was normal.³ A mycologist identified *A muscaria* in the leftover mushroom meal.³ The patient was treated with oral activated charcoal and awoke oriented 10 hours after ingestion but deteriorated mentally 18 hours after ingestion with confusion and uncooperativeness.³ Paranoid psychosis with auditory and visual hallucinations developed and lasted for 5 days before resolving completely.³

Poisoning in children is characterized by initial drowsiness and somnolence followed by ataxia, confusion, dizziness, hyperkinetic activity, seizures, and postictal coma. In 2008, Hoegberg et al reported a series of 3 children (2 girls and 1 boy, aged 4–5 years) from the same nature-oriented kindergarten who had ingested *A muscaria*.⁴ One girl had consumed some bites of *A muscaria* caps and was admitted with somnolence progressing to unconsciousness and respiratory arrest with miotic pupils and stable vital signs.⁴ She underwent endotracheal intubation for mechanical ventilation. She awoke confused 8 hours after admission.⁴ The second girl also ingested bites of *A muscaria* caps but vomited shortly thereafter and vomited twice more after 2 oral doses of activated charcoal.⁴ Vital signs and mental status remained normal.⁴ The boy consumed an entire mushroom and became confused and drowsy with hallucinations on admission that progressed to unconsciousness with a cholinergic syndrome characterized by miosis, bradycardia, and respiratory insufficiency.⁴ He underwent endotracheal intubation for mechanical ventilation. He awakened with dizziness and painful photophobia the next morning, both of which resolved within 2 hours.⁴ All 3 children were discharged from the hospital without sequelae within 20 hours of admission.⁴

Conclusions

A muscaria mushrooms are frequently encountered and are easily recognized. Poisoning after ingestion typically occurs in 3 high-risk groups with different outcomes.

Adolescents and young adults may consume *A muscaria* intentionally for psychedelic effects, experience auditory and visual hallucinations followed by prolonged somnolence, and recover without sequelae. Mushroom foragers may consume the largest amounts of *A muscaria* unintentionally after mistaking them for edible *A caesarea*. They manifest more significant neurotoxicity, including initial obtundation followed by seizure activity and postictal coma. Prolonged paranoid psychosis may occur and resolve within a week. Children are at the greatest risk of severe neurotoxicity after *A muscaria* ingestion, with initial somnolence progressing to seizures, coma, and respiratory arrest requiring intensive care. There is no antidote for *A muscaria* poisoning, and treatment is entirely supportive. The administration of activated charcoal and gastric lavage are no longer indicated in such cases and carry significant inherent risks, including pulmonary aspiration and gastroesophageal injury, especially in pediatric cases. Intravenous benzodiazepines are, however, often indicated for combativeness, hyperactivity, and seizure control in adults and children. Endotracheal intubation for airway maintenance and mechanical ventilation may also be indicated, especially in children.

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