It is Fourth of July weekend, and you are prepared for the many unscheduled appointments, from patients with gastroenteritis due to downing hot dogs to those suffering from noise phobia. However, the patients you end up seeing are neither fearful nor full of food.

In the exam room, Mrs. Smith explains that her dog ate firecrackers. A technician takes a phone call and reports that Mr. Jones is coming in—his dog ingested sparklers. Then the whole Doe family arrives with their dog: while walking by the river this morning, Fido chewed on remains of the municipal fireworks.

Should you worry about these patients? Hospitalize? Refer? How do you treat?

FIREWORK INGREDIENTS
Fireworks are a class of low explosive pyrotechnic devices that contain many different ingredients (Table 1, page 66). To produce combustion, fireworks require a:

- **Binder:** Typically dextrin and rarely contributes to toxicity
- **Fuel:** Typically black powder (gunpowder), a mixture of sulfur, carbon (charcoal), and potassium nitrate (saltpeter); aluminum powder (flash powder) may be used for brighter explosions
- **Oxidizing agent:** Produces oxygen to support fuel combustion; includes nitrates, chlorates, or perchlorates
- **Reducing agent:** Burns the oxygen provided by oxidizing agent; frequently includes both sulfur and charcoal
- **Regulator:** Controls the speed of the reaction, with various metals used
- **Coloring agent:** Provides color but does not contribute to combustion.

Chemical reactions during the combustion process affect kinetics, bioavailability, and toxicity of various ingredients; therefore, spent fireworks can have different compositions than unused fireworks.

TYPES OF FIREWORKS
Common fireworks include firecrackers, smoke bombs, sparklers, snakes, and bottle rockets (Table 2), and these are the types of fireworks your patients will most likely ingest.
LEGALITY OF FIREWORKS

Most states and cities have stringent regulations regarding the purchase and use of fireworks, and differentiate between fireworks available for purchase by consumers versus licensed pyrotechnicians. The United States government uses the United Nations explosives shipping classification system to categorize fireworks: Class 1.3G includes most display fireworks, which require a Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) permit to purchase. Class 1.4G consists of consumer fireworks, which can contain a maximum of 50 mg of explosive material. Illegal consumer fireworks, such as M-80 and M-100 firecrackers and cherry bombs, are sometimes sold as legal consumer fireworks. To

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>USE</th>
<th>EFFECTS AFTER INGESTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>Silver and white flames and sparks (common in sparklers)</td>
<td>Poor oral absorption; little risk of toxicity</td>
</tr>
<tr>
<td>Antimony (antimony sulfide)</td>
<td>Glitter effects</td>
<td>Poor oral absorption; poisoning is very rare</td>
</tr>
<tr>
<td>Barium (barium chlorate, barium nitrate)</td>
<td>Green color; can help stabilize other volatile elements</td>
<td>See Table 3, page 68</td>
</tr>
<tr>
<td>Beryllium</td>
<td>White sparks</td>
<td>Poor oral absorption; inhalation can cause lung cancer</td>
</tr>
<tr>
<td>Calcium (calcium chloride)</td>
<td>Orange color; used to deepen other colors</td>
<td>Poor GI tract absorption; however, calcium chloride is corrosive and can cause oral/esophageal ulceration and GI hemorrhage. See Table 3 (Chlorates)</td>
</tr>
<tr>
<td>Cesium (cesium nitrate)</td>
<td>Indigo color</td>
<td>Toxicity is of minor importance</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Component of many oxidizers in fireworks</td>
<td>Toxicity is of minor importance</td>
</tr>
<tr>
<td>Copper (copper chloride, copper halides)</td>
<td>Blue color</td>
<td>Copper salts are locally corrosive</td>
</tr>
<tr>
<td>Iron</td>
<td>Gold sparks</td>
<td>The amount of iron in fireworks is generally minimal; toxicity is of minor importance</td>
</tr>
<tr>
<td>Lithium (lithium carbonate)</td>
<td>Red color</td>
<td>While toxicity is of minor importance, vomiting is common</td>
</tr>
<tr>
<td>Magnesium</td>
<td>White sparks and improves brilliance</td>
<td>Toxicity is of minor importance</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Glow-in-the-dark effects; may be a component of the fuel</td>
<td>Red phosphorus (safety matches) is an insoluble substance and nontoxic in oral ingestions, whereas white phosphorus (fireworks) can cause severe gastroenteritis and cardiotoxic effects</td>
</tr>
<tr>
<td>Potassium (potassium nitrate, potassium perchlorate)</td>
<td>Violet color; black powder explosive used to oxidize fireworks mixtures</td>
<td>Animals with normal renal function have minimal toxicity consisting of GI signs</td>
</tr>
<tr>
<td>Rubidium (rubidium nitrate)</td>
<td>Violet color</td>
<td>Toxicity is of minor importance</td>
</tr>
<tr>
<td>Sodium (sodium nitrate)</td>
<td>Gold or yellow color</td>
<td>See Table 3 (Nitrates)</td>
</tr>
<tr>
<td>Strontium (strontium carbonate)</td>
<td>Red color; used to stabilize fireworks mixtures</td>
<td>Toxicity is of minor importance; mild vomiting and diarrhea may be seen</td>
</tr>
<tr>
<td>Sulfur (sulfur dioxide)</td>
<td>Component of black powder</td>
<td>Vomiting and diarrhea are common after ingestion</td>
</tr>
<tr>
<td>Titanium</td>
<td>Silver sparks</td>
<td>Poor oral absorption; heavy dust exposures can cause coughing and dyspnea</td>
</tr>
<tr>
<td>Zinc</td>
<td>Smoke effects</td>
<td>Zinc salts can cause vomiting, diarrhea, and GI ulcers; however, firework ingestions rarely cause zinc toxicity</td>
</tr>
</tbody>
</table>
add to the confusion, illegal and legal fireworks may share similar names. Legal fireworks can be identified by the:
• Manufacturer name on the item or box
• Provision of instructions for proper use and list of cautions.
Illegal fireworks should be reported to the ATF.5

CLINICAL SIGNS
In small animal practice, chlorate and barium result in the most problems associated with firework ingestion. As mentioned earlier, composition of spent versus unused fireworks can affect toxicity. Unused (unexploded) consumer/fireworks can cause gastroenteritis in dogs. Unused display/fireworks can cause methemoglobinemia, along with vomiting, diarrhea, lethargy, abdominal pain, and salivation. Chlorates are not only local irritants, causing GI effects, but potent oxidizing agents that can oxidize red blood cells, causing hemolysis and methemoglobin formation.

Spent display fireworks from municipal displays cause more severe clinical signs. Often there is a significant amount of spent ash present, and the ash contains large amounts of more toxic firework components, such as barium (Table 3).

Illegal fireworks may be more likely to cause methemoglobinemia because they frequently contain high levels of chlorates (Table 3).

DIAGNOSIS
In most patients, history provides enough information to diagnose firework ingestion. However, if a symptomatic dog is presented with an unknown history, the potential differential diagnosis for methemoglobinemia includes ingestion of acetaminophen, onions or garlic, aniline dyes, naphthalene, and phenazopyridine. Hemorrhagic gastroenteritis can be caused by parvoviral enteritis, arsenic, and dietary indiscretion.

MANAGEMENT
If a client reports that the pet has ingested fireworks, try to determine:
• The brand of firework and amount (eg, one firecracker or a box)
• Whether firework was legal type of firework
• Where the firework was purchased: Illegal fireworks may be purchased from unauthorized firework stands, in other states or countries (ie, Mexico), from movie/TV production companies/suppliers, or through the Internet.

Frequently, the answers to these questions are unknown and treatment is based on clinical signs.

Emesis Induction
If the pet is asymptomatic and ingestion occurred less than 1 hour previously, emesis may be induced:
• If the fireworks contain barium, magnesium sulfate precipitates barium in the GI tract and prevents further absorption.
• If the fireworks contain chlorates, administration of mineral oil may prevent absorption as well as speed transit time through the GI tract. However, administer mineral oil with caution; if the oil is aspirated, lipid pneumonitis may occur.

However, if the ingredients are known to be corrosive, do not induce emesis. Note that activated
Charcoal does not bind to chlorates or heavy metals and, thus, is not recommended.

**Critical Care**

IV fluids can be used to maintain normal blood pressure and urine production, and saline diuresis increases excretion of barium. If the animal is cyanotic, oxygen is recommended. Oxygen saturation and electrolytes, especially potassium, should be monitored. In addition, obtain a complete blood count, measure liver and renal function (baseline and at 24, 48, and 72 hours), and assess urine output.

**Chlorate Toxicity**

Chlorates are slowly excreted unchanged from the kidneys and may damage the renal proximal tubules, causing renal vasoconstriction; renal enzymes may be elevated. Chlorates can also cause hyperkalemia.

- Chlorates, especially sodium chlorate, can cause vomiting, tachycardia, hemolysis, hyperkalemia (secondary to methemoglobinemia and hemolysis), methemoglobinemia, and nephropathy (secondary to hemolysis).
- Methemoglobinemia may develop within an hour or, in rare cases, be delayed for 10 hours.

Additional therapies include:

- Adding sodium thiosulfate (2–5 g in 200 mL of 5% sodium bicarbonate PO or IV) to mineral oil to inactive chlorate ions.
- Administering sodium bicarbonate (1–2 mEq/kg IV; titrate up as needed) to shift potassium extracellularly; then monitor acid–base status carefully.
- Using blood transfusions to treat hemolytic anemia.

**Barium Toxicity**

The primary treatment for barium toxicity is to correct profound hypokalemia.

- Potassium chloride (not to exceed 0.5 mEq/kg/H IV) can be used to treat cardiac arrhythmias, hypokalemia, and diarrhea caused by barium.
- If severe cardiac arrhythmias are present, measurement of troponin I levels is recommended, with subsequent echocardiography and cage rest, if needed.

**Corrosive Salts**

If the ingested fireworks contained corrosive salts,
monitor for oral and/or esophageal ulcers, which may not be noted for 12 or more hours. However, oral and esophageal burns are rare in cases of firework ingestions.

- **Sucralfate slurries** (0.25–1 g PO Q 6–8 H) and **famotidine** (0.5–1 mg/kg PO, SC, IM, or IV) can be used to treat gastric irritation.

- **Proton pump inhibitors**, such as omeprazole (0.5–1 mg/kg PO Q 24 H), can also be used, especially for esophagitis.

- **Opioids** should be administered to address the pain of oral and esophageal ulcers, as needed.

- **Soft or liquid diets** should be fed. In patients with severe ulcers, an esophagostomy or gastrostomy tube may be required.

- A **broad-spectrum antibiotic** should be administered due to the risk for bacterial translocation.

PROGNOSIS & RECOVERY

Most patients that have ingested fireworks respond well to symptomatic and supportive care. Recovery usually takes 24 to 72 hours (10–14 days for oral or esophageal burns). Ingestion of fireworks is just one more reason to leave dogs safely confined indoors during celebrations that end with a bang.

APCC = Animal Poison Control Center; ATF = Bureau of Alcohol, Tobacco, Firearms and Explosives; GI = gastrointestinal

**References**


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