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# Rats!

## A Toxic Ingestion in an Unattended Toddler

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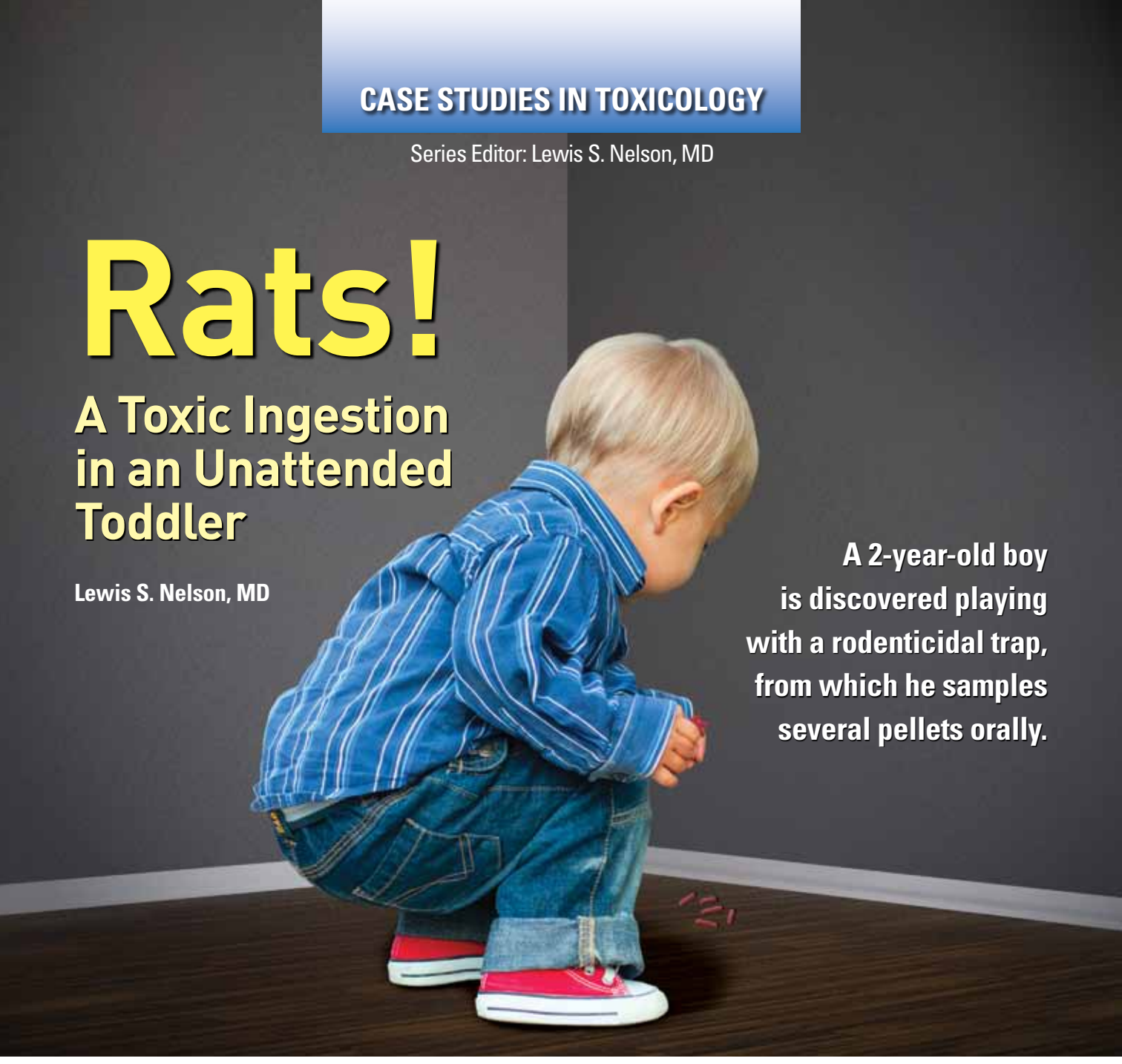

**A 2-year-old boy is discovered playing with a rodenticidal trap, from which he samples several pellets orally.**



### Case

A 2-year-old child is found by his mother playing with a rodenticidal bait placed in the corner of the living room. The mother removes several pellets of the substance from the child's mouth and brings him to the ED within 30 minutes of exposure. The emergency physician finds him to be asymptomatic, with normal vital signs and a normal physical examination.

### What rodenticides are available for home use?

The most likely exposure in this child is to a long-acting anticoagulant (LAA) rodenticide. LAAs, also known as superwarfarins, are widely available in retail outlets and are prized for their relative safety compared to previously available—and toxic—rodenticides, such as strychnine, zinc phosphide, and cholecalciferol. These substances, however, remain available for commercial use, and antiquated rodenticides, including barium, cyanide, and thallium, are occasionally found in attics by curious children.[1]

In response to the recognized dangers of rodenticides and other pesticides, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and subsequent laws empower the Environmental Protection Agency to regulate these chemicals. Although legislation exists to remove

LAAs from the consumer market due to lingering safety concerns among children and wildlife, it has not yet been implemented.

Rodenticides of particular and practical concern are those imported into the United States—by people who might not recognize the illegality or the dangers of these products. For example, Tres Pasitos, a product allegedly imported from the Dominican Republic, contains aldicarb, a potent carbamate cholinesterase inhibitor. This chemical has limited agricultural use in some states as an insecticide, but is not approved for use by unlicensed personnel and certainly not for home use. Clinical findings following exposure to Tres Pasitos and other carbamate cholinesterase inhibitors are those typical of exposure to the related organophosphorus insecticides, including increased glandular secretions, vomiting and diarrhea, life-threatening bronchorrhea, and neuromuscular weakness (cholinergic toxidrome).[2] In addition to supportive care and attentive ventilatory management, the therapeutic approach to aldicarb toxicity includes the use of pralidoxime, a cholinesterase reactivator, along with progressive doses of atropine.

Another dangerous rodenticide, Dushuqiang, is illicitly imported from China. It contains tetramine (tetramethylene disulfotetramine), a potent convulsant that likely works by blocking inhibitory neuronal chloride channels. Ingestion may result in status epilepticus. Although only a single case has been identified in the United States, this rodenticide has produced epidemic poisoning and death in China.[3] Various compounds, such as pyridoxine and sodium dimercaptopropane sulfonate, have purported beneficial effects in tetramine-poisoned patients, but none has been adequately studied.

Fortunately, the availability of most of these alarming toxins is limited, and most have a rapid onset of clinical effect. For the majority of asymptomatic patients with exposure to one of the older rodenticides, Tres Pasitos, or Dushuqiang, an observation period of several hours is generally sufficient to exclude poisoning. The corollary is that the failure to manifest overt signs of poisoning following a documented exposure to a rodenticide generally, though not always, implicates an anticoagulant agent.

## What are anticoagulant rodenticides?

Humans and rodents share a similar physiology, and chemicals that are highly effective rodenticides, with a few exceptions, are also highly toxic to humans. The anticoagulant rodenticides are generally considered to be of low lethality to humans, however. Theoretically, they should be equally toxic to both man and rodent, but they take advantage of the dramatically different living conditions of the two. Humans live a relatively atraumatic lifestyle in which being anticoagulated is compatible with longevity. Rodents, on the other hand, routinely are required to squeeze through holes, jump from heights, and undertake other potentially injurious actions. Thus, even humans who develop clinically relevant anticoagulation following a rodenticide exposure tend to have excellent outcomes, provided they do not develop spontaneous or provoked hemorrhage. The anticoagulant rodenticides have a mechanism analogous to warfarin: they prevent the activation of vitamin K, thereby inhibiting the activation of relevant clotting factors (II, VII, IX, X). Most are of the long-acting type, and even a single ingestion in rodent or human can produce anticoagulation lasting weeks or longer.

There were more than 9,500 exposures to LAA rodenticides reported to poison control centers in 2011, making these the second most frequently reported class of pesticide exposure after the pyrethroid/pyrethrin insecticides.[4] As with many other poison exposures, the two common means by which exposures occur are intentional ingestion, usually in the setting of attempted suicide, and unintentional ingestion, generally as an exploratory finding in a child between the ages of 1 and

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4 years old. Intentional ingestion routinely leads to numerical and clinical anticoagulation, while unintentional ingestion rarely results in either. Paradoxically, this complicates the management of the latter group of patients. Of the anticoagulant rodenticide exposures that were reported in 2011, approximately 2.5% were to warfarin-type (short-acting) products and the remainder was to superwarfarin, or long-acting anticoagulant, products, such as brodifacoum.[4]

## How should patients with anticoagulant rodenticide exposure be managed?

Hemorrhage is uncommon on presentation since the onset of anticoagulation generally occurs approximately 24 hours after exposure. If present, it must be controlled, and blood products such as prothrombin complex, which contains clotting factors II, VII, IX, and X, should be administered as needed. All patients should be assured of a safe environment pending the discovery of those who develop a coagulation disorder. Gastrointestinal decontamination is generally limited to oral activated charcoal, and the utility of even that measure is unproven.

Historically, patients presenting with intentional or unintentional exposure to superwarfarin rodenticides had INR measured daily for 2 or 3 days. Although this is not a point of contention for the few patients with intentional (and generally large) exposure, there is controversy over the need to monitor INR for the thousands of children with unintentional exposure. This controversy stems from the fact that few children with unintentional exposure develop an elevated INR, and the sequelae in those who do are typically minor. However, in many of these cases, rodenticide may not have even been ingested, promoting a false sense of benignity in those with actual consumption.

Some poison control centers recommend management of these patients as essentially nontoxic exposures, with home observation and parental education, and indicating that an ED visit or immediate evaluation is not needed. Decision-making should be tempered by the fact that a poor outcome in even a single child with this type of readily evaluable toxic exposure is unacceptable. Although the vast majority of children with a superwarfarin rodenticide exposure will have an excellent outcome, it seems reasonable for a child to have an INR measured at 48 to 72 hours postexposure to exclude clinically significant exposure by documenting normal coagulation parameters.

Patients who develop an elevated INR after a superwarfarin overdose should be given prolonged oral vitamin K1 therapy. Pharmacologic doses (10-100 mg daily) are generally required because the reactivation of inactive vitamin K is interrupted by the anticoagulant rodenticides, and physiologic quantities of vitamin K depend on the normal ability to recycle the inactivated vitamin. Monitoring of INR or clotting factor levels is generally recommended to determine the progress of therapy.[5] The empiric prescribing of vitamin K to LAA-exposed patients without documentation of a coagulopathy is not ideal. Since the parent (or patient) is unlikely to properly continue therapy for the required month or longer, a covert and delayed rise in INR with sequelae is possible. Those who ingest LAA-type rodenticides rarely develop clinical anticoagulation, and several days of oral vitamin K1 should allow the rodenticide to be eliminated and coagulation to normalize. Thus, in these patients, there is no need for testing.

## Case conclusion

The boy had a normal baseline INR and was discharged to follow-up with his pediatrician. The parents were given clear instructions on limiting the child's activities to minimize the risk of injury until follow-up (eg, limiting playground time). They were given poison-prevention information and advised to return to the ED if any bleeding occurred. The pediatrician reported a normal INR drawn at approximately 48 hours after exposure.

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