A 3-year-old, 20-kg neutered male mixed breed dog was presented for acute hemoptysis.

**HISTORY**
A few hours prior to presentation, the owner noticed that the dog was weak and coughing up blood. No vomiting, diarrhea, or changes in urination were reported. He was the only pet, and kept in a fenced yard. The dog was current on vaccinations, and not receiving any medications.

**PHYSICAL EXAMINATION**
The mucous membranes were pale pink, with a capillary refill time of 1.5 seconds. Some blood was noted in the oral cavity. Heart sounds were normal, with a rate of 140 beats per minute; pulses were strong. He was mildly tachypneic, with harsh lung sounds auscultated bilaterally.

During the examination, the dog started coughing. The cough sounded wet, and more blood was expectorated. No petechiae or ecchymoses were found. Normal stool was seen on rectal examination. The rest of the physical examination was within normal limits (WNL).

**DIFFERENTIAL DIAGNOSES**
Based on history and physical examination, trauma was not considered a likely diagnosis. The main differentials considered were:
- Coagulopathy
- Bleeding primary lung lesion, such as a neoplasm.

**INITIAL DIAGNOSTICS**

**Laboratory Analysis**
Blood smear examination revealed an adequate number of platelets (estimated 250,000/mcL); morphology and number of white and red blood cells were WNL. Packed cell volume was 30%, and total solids were 6 g/dL.

**Other Diagnostics**
Pulse oximetry measured hemoglobin oxygen saturation at 96% on room air. Chest radiographs demonstrated an asymmetrical, patchy alveolar lung pattern and small amount of pleural effusion (Figure).

**FURTHER DIAGNOSTICS**
Because the radiographs did not document a specific lung lesion, such as a neoplastic mass, additional testing was warranted. Pertinent results from additional blood analysis are listed in Table 1.

Complete blood count and serum biochemical profile were WNL, except for mild anemia. Prothrombin time (PT) was extremely prolonged, and activated partial thromboplastin time (aPTT) was mildly prolonged.

**DIAGNOSIS**
Based on the clinical signs and diagnostic findings in this dog, a secondary coagulopathy (ie, defect of coagulation factors) was suspected (Table 2, page 22). See General Approach to Coagulopathies for further information on primary and secondary coagulopathies.
Measurement of D-dimers
In addition to measuring PT, aPTT, and platelet count, measuring d-dimers and fibrin degradation products (FDPs) may be helpful in distinguishing between different types of secondary defects.

D-dimers are a type of FDP derived specifically from breakdown of cross-linked fibrin. Increased blood levels of d-dimers and/or FDPs detect activation of the fibrinolytic system, which is activated whenever coagulation factors are consumed. This activation is common in animals with intravascular thrombosis and/or disseminated intravascular coagulopathy.

FDPs and D-dimers are removed from circulation by the liver; therefore, they also may be mildly to moderately elevated in animals with liver disease.

Definitive Diagnosis
In this dog, the D-dimer concentration was 0.15 mcg/mL (reference range, < 0.2 mcg/mL). This normal result, combined with a severely prolonged PT, mildly prolonged aPTT, and normal platelets strongly suggested a clinical diagnosis of anticoagulant rodenticide toxicity (vitamin K deficiency); however, hereditary clotting factor VII deficiency could not be ruled out completely.

Diagnosis of anticoagulant rodenticide toxicity is often clinically confirmed retrospectively based on a favorable response to vitamin K1 therapy. If PT remains persistently prolonged despite vitamin K1 supplementation, clotting factor analysis is necessary to diagnose hereditary deficiency of clotting factor VII.

Pathophysiology of Anticoagulant Rodenticide Toxicosis
Anticoagulant rodenticides block the recycling of vitamin K epoxide to vitamin K hydroquinone, which is an essential cofactor in hepatic synthesis of functional clotting factors II, VII, IX, and X. The half-lives of these clotting factors are 40, 6, 14, and 16 hours, respectively. Depletion of these clotting factors affects the extrinsic, intrinsic, and common coagulation pathways, resulting in clinical bleeding typically 2 to 5 days post exposure.

Anticoagulant Rodenticide Toxicity
In anticoagulant rodenticide toxicity:
1. PT becomes prolonged first (usually 48–72 hours post toxin ingestion) due to the short half-life of clotting factor VII (4–6 hours).
2. As other functional vitamin K-dependent clotting factors deplete with time, aPTT and activated clotting time (ACT) then become prolonged as well. Therefore, with anticoagulant rodenticide toxicity, PT is disproportionally prolonged compared to aPTT.
3. Platelets are not directly affected by anticoagulant rodenticides, although in animals with severe bleeding, platelet counts may drop significantly as platelets are consumed in an attempt to stop hemorrhaging.

<table>
<thead>
<tr>
<th>TEST</th>
<th>RESULT</th>
<th>REFERENCE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematocrit (%)</td>
<td>29</td>
<td>40.3–60.3</td>
</tr>
<tr>
<td>Prothrombin time (sec)</td>
<td>&gt; 200</td>
<td>6.8–10.2</td>
</tr>
<tr>
<td>Activated partial thromboplastin time (sec)</td>
<td>18</td>
<td>10.7–16.4</td>
</tr>
</tbody>
</table>
The dog was treated with 2 units of fresh frozen plasma, and vitamin K1 therapy was initiated (2.5 mg/kg PO Q 12 H). Recheck PT and aPTT were WNL after the transfusion. The patient remained stable, with no further evidence of bleeding, and was discharged the next day with a course of vitamin K1 therapy. The owner reported that coughing subsided in 3 to 4 days.

**Vitamin K1 Therapy**

Vitamin K1 is the most commonly used antidote for anticoagulant rodenticide. It is a more effective and safer therapeutic agent than vitamin K3, which has been reported to cause hemolytic anemia in dogs.

**Administration.** Vitamin K1 is well absorbed orally and subcutaneously. Gastrointestinal absorption can be further enhanced by feeding a fatty meal at time of drug administration.

**TREATMENT**

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administration, and portal circulation carries the absorbed vitamin K1 to the liver directly for clotting factor production.

Anaphylaxis has been reported with intravenous vitamin K1 administration; intramuscular injections may cause local hemorrhage and should be avoided in hypocoagulable animals.

Duration. The necessary duration of vitamin K1 therapy is directly related to the elimination half-life of the anticoagulant rodenticide ingested.

- First-generation anticoagulant rodenticides (eg, warfarin, coumarin) are metabolized within 14 days.
- Second-generation anticoagulant rodenticides (eg, bromadiolone, brodifacoum) are more potent, with prolonged toxic effects, requiring 4 weeks of therapy or, in some cases, longer.

At-Home Therapy
In this case, since the exact type of anticoagulant rodenticide ingested was unknown, a 4-week course of therapy was prescribed. A follow-up appointment was planned to re-evaluate PT 48 to 72 hours after completion of treatment to ensure adequate duration of therapy.

Follow-Up
Four weeks later, the dog was presented for recheck PT testing 48 hours after the last dose of vitamin K1. PT was normal, and the dog made a full recovery.

If residual toxin had remained, PT would have become prolonged during the 48 to 72 hours after therapy completion. In these cases, vitamin K1 supplementation should be administered for another 1 to 2 weeks, and PT re-evaluated at therapy end.

PREVENTION
To avoid repeat ingestion, it is important to ask owner to:
- Thoroughly inspect the home environment and remove any remaining rodenticide found on premises
- Search for, and remove, rodenticide from any place that the pet may have visited during the past few days, as bleeding due to anticoagulant rodenticide typically begins 2 to 5 days after exposure.
- Repeat ingestion of similar toxins may cause relapse of bleeding once vitamin K1 therapy is discontinued.

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IN SUMMARY

Anticoagulant rodenticides are a common cause of coagulopathy encountered in veterinary medicine.

- Clinical presentation of this bleeding diathesis is variable and shared by many other hemostatic disorders.
- Acute hemoptysis alone is a less common clinical presenting complaint.
- Initial clinical signs are often vague and may include lethargy, weakness, or acute dyspnea due to cavitary bleeding in the chest and/or abdomen.
- A systematic approach to differentiate anticoagulant rodenticide toxicity from other hemostatic disorders is key to early diagnosis and successful treatment.

ACT = activated clotting time; aPTT = activated partial thromboplastin time; EPA = environmental protection agency; FDPs = fibrin degradation products; PT = prothrombin time; WNL = within normal limits

Suggested Reading


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