Management of North American Pit Viper Envenomation

CUSTOMIZABLE TREATMENT PLAN

These pages can be printed so that you can chart your patient’s progress.

<table>
<thead>
<tr>
<th>Patient Name</th>
<th>Notes</th>
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<td>_______________________________</td>
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<th>Notes</th>
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<th>Date</th>
<th>Notes</th>
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<th>Time</th>
<th>Notes</th>
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<td>_______________________________</td>
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**Patient Assessment**

1. **Assess Patient**
   - Mark leading edge of swelling and tenderness every 15-30 minutes
   - Immobilize and elevate extremity
   - Treat pain (IV opioids preferred)
   - Obtain initial lab studies (protime, Hgb, platelets, fibrinogen)
   - Update tetanus vaccine
   - Contact poison control center (1-800-222-1222)

2. **Check for Signs of Envenomation**
   - Swelling, tenderness, redness, ecchymosis, or blebs at the bite site, or
   - Elevated protime; decreased fibrinogen or platelets, or
   - Systemic signs, such as hypotension, bleeding beyond the puncture site, refractory vomiting, diarrhea, angioedema, neurotoxicity

3. **Check for Progression of Clinical Effects**
   - Swelling that is more than minimal and that is progressing, or
   - Elevated protime; decreased fibrinogen or platelets, or
   - Any systemic signs

9. **Apparent Dry Bite / No Bite**
   - Do not administer CroFab®
   - Observe patient ≥8 hours
   - Repeat labs prior to discharge
   - If patient develops signs of envenomation, return to box 2

10. **Apparent Minor Envenomation**
    - Do not administer CroFab®
    - Observe patient 12-24 hours
    - Repeat labs at 4-6 hours and prior to discharge
    - If patient develops progression of any signs of envenomation, return to box 3

**Patient Assessment Notes**

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___________________________________________________________________________________
Management of North American Pit Viper Envenomation

CUSTOMIZABLE TREATMENT PLAN

CroFab® Crotalidae Polyvalent Immune Fab (Ovine) Administration

4. **Administer CroFab®**
   - Establish IV access and give IV fluids
   - Pediatric CroFab® dose = adult dose
   - Mix 4-6 vials of CroFab® in 250 ml NS and infuse IV over 1 hour
     - For patients in shock or with serious active bleeding call physician-expert (see box 12)
   - Initiate first dose of CroFab® in ED or ICU
     - For suspected adverse reaction: hold infusion, treat accordingly, and call physician-expert
   - Re-examine patient for treatment response within 1 hour of completion of CroFab® infusion

5. **Determine if Initial Control of Envenomation has been Achieved**
   - Swelling and tenderness not progressing
   - Protime, fibrinogen, and platelets normal or clearly improving
   - Clinically stable (not hypotensive, etc.)
   - Neurotoxicity resolved or clearly improving

6. **Monitor Patient**
   - Perform serial examinations
   - Maintenance CroFab® therapy may be indicated
     - Read Box 13 (Maintenance CroFab® Therapy)
   - Observe patient 18-24 hours after initial control for progression of any venom effect
   - Follow-up labs 6-12 hours after initial control and prior to discharge
   - If patient develops new or worsening signs of envenomation, administer additional doses of CroFab® per box 4

7. **Determine if Patient Meets Discharge Criteria**
   - No progression of any venom effect during the specified observation period
   - No unfavorable laboratory trends in protime, fibrinogen, or platelets

11. **Repeat CroFab® Until Initial Control is Achieved**
    - If initial control is not achieved after 2 doses of CroFab®, call physician-expert (see box 12)

Administration Notes

___________________________________________________________________________________
___________________________________________________________________________________
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Patient Monitoring Notes

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Monitor Patient

Patient Monitoring
Management of North American Pit Viper Envenomation

CUSTOMIZABLE TREATMENT PLAN

Maintenance Therapy

Maintenance Therapy Notes

Post-Discharge Planning

Post-Discharge Planning Notes

Maintenance Therapy

**Maintenance CroFab® Therapy**
- Maintenance therapy is additional CroFab® given after initial control to prevent recurrence of limb swelling
  - Maintenance therapy is 2 vials of CroFab® Q6H x 3 (given 6, 12, and 18 hours after initial control)
  - Maintenance therapy may not be indicated in certain situations, such as:
    - Minor envenomations
    - Facilities where close observation by a physician-expert is available
  - Follow local protocol or contact a poison center or physician-expert for advice

Post-Discharge Planning

**Post-Discharge Planning**
- Instruct patient to return for:
  - Worsening swelling that is not relieved by elevation
  - Abnormal bleeding (gums, easy bruising, melena, etc.)
  - Instruct patient where to seek care if symptoms of serum sickness (fever, rash, muscle/joint pains) develop
  - Bleeding precautions (no contact sports, elective surgery, or dental work, etc.) for 2 weeks in patients with:
    - Rattlesnake envenomation
    - Abnormal protime, fibrinogen, or platelet count at any time
  - Follow-up visits
    - CroFab® not given:
      - PRN only
    - CroFab® given:
      - Copperhead victims: PRN only
      - Other snakes: Follow up with labs (protime, fibrinogen, platelets, hemoglobin) twice (2-3 days and 5-7 days), then PRN
ADDITIONAL TREATMENT INFORMATION: Please review these additional sections of the Management of North American Pit Viper Envenomation treatment algorithm.

**When to Call a Physician-Expert**

Direct consultation with a physician-expert is recommended in certain high-risk clinical situations:

- **Life-threatening envenomation**
  - Shock
  - Serious active bleeding
  - Facial or airway swelling

- **Hard-to-control envenomation**
  - Envenomation that requires more than 2 doses of CroFab® for initial control

- **Recurrence or delayed onset of venom effects**
  - Worsening swelling or abnormal labs (protime, fibrinogen, platelets, or hemoglobin) on follow-up visits

- **Allergic reactions to CroFab®**

- **If transfusion is considered**

- **Uncommon clinical situations**
  - Bites to the head and neck
  - Rhabdomyolysis
  - Suspected compartment syndrome
  - Venom-induced hives and angioedema

- **Complicated wound issues**

If no local expert is available, a physician-expert can be reached through a certified poison center (1-800-222-1222) or the CroFab® manufacturer’s line (1-877-377-3784).

**Treatments Not Proven to Be Beneficial in the Management of Pit Viper Envenomation**

- Cutting and/or suctioning of the wound
- Ice
- NSAIDs
- Prophylactic antibiotics
- Prophylactic fasciotomy
- Routine use of blood products
- Shock therapy (electricity)
- Steroids (except for allergic phenomena)
- Tourniquets

**Notes:**

- This worksheet is adapted from general advice from a panel of US snakebite experts convened in May 2010. No algorithm can anticipate all clinical situations. Other valid approaches exist, and deviations from this worksheet based on individual patient needs, local resources, local treatment guidelines, and patient preferences are expected. This document is not intended to represent a standard of care. For more information, please see the accompanying manuscript, available at www.biomedcentral.com.

Management of North American Pit Viper Envenomation

CUSTOMIZABLE TREATMENT PLAN

Indication
CroFab® Crotalidae Polyvalent Immune Fab (Ovine) is an antivenin indicated for the management of patients with North American crotalid envenomation. The term crotalid is used to describe the Crotalinae subfamily (formerly known as Crotalidae) of venomous snakes that includes rattlesnakes, copperheads, and cottonmouths/water moccasins. Early use of CroFab® (within 6 hours of snakebite) is advised to prevent clinical deterioration and the occurrence of systemic coagulation abnormalities.

Important Safety Information
The most common adverse events reported in clinical studies were mild or moderate reactions involving the skin and appendages (primarily urticaria, rash, or pruritus), which occurred in 14 out of 42 patients. Three patients experienced a serious adverse event. Two patients had a severe allergic reaction (severe hives and a severe rash and pruritus) following treatment. One patient had a recurrent coagulopathy due to envenomation, which required rehospitalization and additional antivenin administration. In clinical trials, recurrent coagulopathy (the return of a coagulation abnormality after it has been successfully treated with antivenin), characterized by decreased fibrinogen, decreased platelets, and elevated prothrombin time, occurred in approximately half of the patients studied. Recurrent coagulopathy may persist for 1 to 2 weeks or more. Patients who experience coagulopathy due to snakebite should be monitored for recurrent coagulopathy for up to 1 week or longer. One patient discontinued CroFab® therapy due to an allergic reaction. Anaphylaxis and hypersensitivity reactions can occur, and patients should be monitored closely during treatment. Patients with allergies to papain, chymopapain, other papaya extracts, or the pineapple enzyme bromelain may also be at risk for an allergic reaction to CroFab®. CroFab® contains mercury in the form of ethyl mercury from thimerosal. The final product contains up to 30 mcg or approximately 0.03 mg of mercury per vial, which amounts to no more than 0.6 mg of mercury per dose (based on the maximum dose of 18 vials studied in clinical trials of CroFab®).

Please see full prescribing information at www.crofab.com. Please see important safety information above.
**INDICATIONS AND USAGE**

CroFab® is an antivenin indicated for the management of patients with North American crotalid envenomation. Early use of CroFab® (within 6 hours of snakebite) is advised to prevent clinical deterioration and the occurrence of systemic coagulation abnormalities. (1)

**CONTRAINDICATIONS**

CroFab® should not be administered to patients with a known history of hypersensitivity to any of its components, or to papaya or papain unless the benefits outweigh the risks and appropriate management for anaphylactic reactions is readily available. (4)

**WARNINGS AND PRECAUTIONS**

- Patients who experience coagulopathy due to snakebite should be monitored for recurrent coagulopathy for up to 1 week or longer. (5.1)
- Anaphylaxis and hypersensitivity reactions can occur and patients should be monitored closely during treatment. Patients with allergies to papain, chymopapain, other papaya extracts, or the pineapple enzyme bromelain may also be at risk for an allergic reaction to CroFab®. (5.2)
- CroFab® contains mercury in the form of ethyl mercury from thimerosal. The final product contains up to 30 mcg or approximately 0.03 mg of mercury per vial, which amounts to no more than 0.6 mg of mercury per dose (based on the maximum dose of 18 vials studied in clinical trials of CroFab®). (5.3)

**ADVERSE REACTIONS**

The most common adverse events reported in clinical studies were mild or moderate reactions involving the skin and appendages (primarily urticaria, rash or pruritus), which occurred in 14 out of 42 patients. Three patients experienced a serious adverse event. Two patients had a severe allergic reaction (severe hives and a severe rash and pruritus) following treatment. One patient had a recurrent coagulopathy due to envenomation, which required re-hospitalization and additional antivenin administration. One patient discontinued CroFab® therapy due to an allergic reaction. (6.1)

To report SUSPECTED ADVERSE REACTIONS, contact 1-877-377-3784 or FDA at 1-800-FDA-1088 or [www.fda.gov/medwatch](http://www.fda.gov/medwatch).

**USE IN SPECIFIC POPULATIONS**

- Pregnancy: No human or animal data. Use only if clearly needed. (8.1)
- Specific studies in pediatric patients have not been conducted. (8.3)

See 16 for PATIENT COUNSELING INFORMATION

Revised: March 2012

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2 DOSAGE AND ADMINISTRATION
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   2.2 Preparation and Administration
3 DOSAGE FORMS AND STRENGTHS
4 CONTRAINDICATIONS
5 WARNINGS AND PRECAUTIONS
   5.1 Coagulopathy
   5.2 Hypersensitivity Reactions
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* Sections or subsections omitted from the full prescribing information are not listed.
2.2 Full Prescribing Information: Contents

1 Indications and Usage
CroFab® is indicated for the management of patients with North American crotalid envenomation (see Table 5 in Clinical Studies section (13) for definitions). The term crotalid is used to describe the Crotalidae subfamily (formerly known as Crotalidae) of venomous snakes which includes rattlesnakes, copperheads, and cottonmouths/water moccasins. Early use of CroFab® (within 6 hours of snakebite) is advised to prevent clinical deterioration and the occurrence of systemic coagulation abnormalities.

2 Dosage and Administration
For Intravenous Use after Reconstitution

2.1 Dosage
- Antivenin dosage requirements are contingent upon an individual patient’s response; however, based on clinical experience with CroFab®, the recommended initial dose is 4 to 6 vials.

- Administration of antivenin should be initiated as soon as possible after crotalid snakebite in patients who develop signs of progressive envenomation (e.g., worsening local injury, coagulation abnormality, or systemic signs of envenomation). CroFab® was shown in the clinical studies to be effective when given within 6 hours of snakebite.

- The patient should be observed for up to 1 hour following the completion of this first dose to determine if initial control of the envenomation has been achieved (as defined by complete arrest of local manifestations, and return of coagulation tests and systemic signs to normal). If initial control is not achieved by the first dose, an additional dose of 4 to 6 vials should be repeated until initial control of the envenomation syndrome has been achieved.

- After initial control has been established, additional 2-vial doses of CroFab® every 6 hours for up to 18 hours (3 doses) is recommended. Optimal dosing following the 18-hour scheduled dose of CroFab® has not been determined. Additional 2-vial doses may be administered as deemed necessary by the treating physician, based on the patient’s clinical course.

- Additional Patient Care (Supportive and Adjunctive Therapy): Supportive measures are often utilized to treat certain manifestations of crotalid snake envenomation, such as pain, swelling, hypotension, and wound infection. Poison control centers are a helpful resource for individual treatment advice.

2.2 Preparation and Administration
- Parenteral drug products should be inspected visually for particulate matter and discoloration prior to administration, whenever solution and container permit.

- Each vial of CroFab® should be reconstituted with 18 mL of 0.9% Saline (diluent not included) and mixed by continuous manual inversion until no solid material is visible in the vial. Do not shake. The contents of all of the reconstituted vials should be further diluted in 250 mL of 0.9% Sodium Chloride USP and mixed by gently swirling.

- The initial dose of CroFab® diluted in 250 mL of saline should be infused intravenously over 60 minutes. However, the infusion should proceed slowly over the first 10 minutes at a 25-50 mL/hour rate with careful observation for any allergic reaction. If no such reaction occurs, the infusion rate may be increased to the full 250 mL/hour rate until completion. Close patient monitoring is necessary.

- The reconstituted and diluted product should be used within 4 hours.

3 Dosage Forms and Strengths
CroFab® is supplied as a sterile, nonpyrogenic, purified, lyophilized powder. Each vial contains up to 1 gram of total protein, a maximum of 0.03 mg of mercury, and not less than the indicated number of mouse LD₅₀ neutralizing units:

<table>
<thead>
<tr>
<th>Snake Species Used for Antivenin Component</th>
<th>Minimum mouse LD₅₀ Units per vial</th>
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<tbody>
<tr>
<td>C. atrox (Western Diamondback rattlesnake)</td>
<td>1270</td>
</tr>
<tr>
<td>C. adamanteus (Eastern Diamondback rattlesnake)</td>
<td>420</td>
</tr>
<tr>
<td>C. scutulatus (Mojave rattlesnake)</td>
<td>5570</td>
</tr>
<tr>
<td>A. piscivorus (Cottonmouth or Water Moccasin)</td>
<td>780</td>
</tr>
</tbody>
</table>

* As of 2008, the potency assay has been optimized for a new strain of mice, which has resulted in changes to the minimum mouse LD₅₀ neutralizing units. These changes do not reflect any change in product potency, but only a different biological response of the mouse strain to the venom.

4 Contraindications
CroFab® should not be administered to patients with a known history of hypersensitivity to papaya or papain unless the benefits outweigh the risks and appropriate management for anaphylactic reactions is readily available.

5 Warnings and Precautions
5.1 Coagulopathy
Coagulopathy is a complication noted in many victims of viper envenomation that arises due to the ability of the snake venom to interfere with the blood coagulation cascade [4, 8, 9], and is seen more frequently in severely envenomated patients. In clinical trials with CroFab®, recurrent coagulopathy (the return of a coagulation abnormality after it has been successfully treated with antivenin), characterized by decreased fibrinogen, decreased platelets, and elevated prothrombin time, occurred in approximately half of patients studied. The clinical significance of these recurrent abnormalities is not known. Recurrent coagulation abnormalities were observed only in patients who experienced coagulation abnormalities during their initial hospitalization, although coagulopathy can initially appear at any time before, during or after treatment. Optimal dosing to completely prevent recurrent coagulopathy has not been determined. Because CroFab® has a shorter persistence in the blood than crotalid venoms that can leak from depot sites over a prolonged period of time, repeat dosing to prevent or treat such recurrence may be necessary (see Dosage and Administration (2)).

Recurrent coagulopathy may persist for 1 to 2 weeks or more. Patients who experience coagulopathy due to snakebite during hospitalization for initial treatment should be monitored for signs and symptoms of recurrent coagulopathy for up to 1 week or longer at the physician’s discretion. During this period, the physician should carefully assess the need for retreatment with CroFab® and use of any type of anticoagulant or anti-platelet drug.

Because snake envenomation can cause coagulation abnormalities, the following conditions, which are also associated with coagulation defects, should be considered: cancer, collagen disease, congestive heart failure, diarrhea, elevated temperature, hepatic disorders, hyperthyroidism, poor nutritional state, steatorrhea, vitamin K deficiency.

5.2 Hypersensitivity Reactions
Severe hypersensitivity reactions may occur with CroFab®. In case of acute hypersensitivity reactions, including anaphylaxis and anaphylactoid reactions, discontinue infusion and institute appropriate emergency treatment.

CroFab® contains purified immunoglobulin fragments from the blood of sheep that have been immunized with snake venoms (see 10 Description). Injection of heterologous animal proteins can cause severe acute and delayed hypersensitivity reactions (late serum reaction or serum sickness) and a possible febrile response to immune complexes formed by animal antibodies and neutralized venom components [10].
Papain is used to cleave antibodies into fragments during the processing of CroFab®, and trace amounts of papain or inactivated papain residues may be present. Patients allergic to papain, chymopapain, other papaya extracts, or the pineapple enzyme bromelain may also have an allergic reaction to CroFab®. Some dust mite allergens and some latex allergens share antigenic structures with papain and patients with these allergies may be allergic to papain.

The following precautions should be used to manage hypersensitivity reactions:

Emergency medical care (e.g., epinephrine, intravenous antihistamines and/or albuterol) should be readily available.

Carefully monitored patients for signs and symptoms of an acute allergic reaction (e.g., urticaria, pruritus, erythema, angioedema, bronchospasm with wheezing or cough, stridor, laryngeal edema, hypotension, tachycardia).

Follow-up all patients for signs and symptoms of delayed allergic reactions or serum sickness (e.g., rash, fever, myalgia, arthralgia).

It has been noted in the literature with the use of other antibody therapies, that reactions during the infusion, such as fever, low back pain, wheezing and nausea are often related to the rate of infusion and can be controlled by decreasing the rate of administration of the solution [11].

Patients who receive a course of treatment with a foreign protein such as CroFab® may become sensitized to it. Therefore, caution should be used when administering a repeat course of treatment with CroFab® for a subsequent envenomation episode.

Skin testing has not been used in clinical trials of CroFab® and is not required.

5.3 Mercury Toxicity

The final product contains up to 30 mcg or approximately 0.03 mg of mercury per vial, which amounts to no more than 0.6 mg of mercury per dose (based on the maximum dose of 18 vials studied in clinical trials of CroFab®). While there are no definitive data on the toxicity of ethyl mercury, literature suggests that information related to methyl mercury toxicities may be applicable.

6 ADVERSE REACTIONS

6.1 Clinical Trials Experience

Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in clinical practice.

- The most common adverse events reported in the clinical studies were urticaria and rash. Adverse events involving the skin and appendages (primarily rash, urticaria, and pruritus) were reported in 14 of the 42 patients (Table 1).
- Of the 25 patients who experienced adverse reactions, 3 patients experienced severe or serious adverse reactions.
  - The 1 patient who experienced a serious adverse event had a recurrent coagulopathy due to envenomation, which required re-hospitalization and additional antivenin administration. This patient eventually made a complete recovery.
  - The other 2 had severe adverse reactions that consisted of 1 patient who developed severe hives following treatment and 1 patient who developed a severe rash and pruritus several days following treatment. Both patients recovered following treatment with antihistamines and prednisone.
- One patient discontinued CroFab® therapy due to an allergic reaction.

Table 1  Incidence of Clinical Adverse Events in Studies of CroFab® by Body System

<table>
<thead>
<tr>
<th>Adverse Events</th>
<th>n=42*</th>
<th>Number of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body as a Whole</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back pain</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chest pain</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cellulitis</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Chills</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Allergic reaction†</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Serum sickness</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Skin and Appendages</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urticaria</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Rash</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Pruritus</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Subcutaneous nodule</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Cardiovascular System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypotension</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Respiratory System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cough</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Increased sputum</td>
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<td></td>
</tr>
<tr>
<td><strong>Digestive System</strong></td>
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</tr>
<tr>
<td>Nausea</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Anorexia</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Hematologic/Lymphatic</strong></td>
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<td></td>
</tr>
<tr>
<td>Coagulation disorder</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Ecchymosis</td>
<td>1</td>
<td></td>
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<tr>
<td><strong>Musculoskeletal</strong></td>
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<td></td>
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<tr>
<td>Myalgia</td>
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<td></td>
</tr>
<tr>
<td><strong>Nervous System</strong></td>
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</tr>
<tr>
<td>Circumoral paresthesia</td>
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<td></td>
</tr>
<tr>
<td>General paresthesia</td>
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<td></td>
</tr>
<tr>
<td>Nervousness</td>
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<td></td>
</tr>
</tbody>
</table>

*  Of the 42 patients receiving CroFab® in the clinical studies, 25 experienced an adverse event. A total of 40 adverse events was experienced by these 25 patients.
†  Allergic reaction consisted of urticaria, dyspnea and wheezing in 1 patient.

In the 42 patients treated with CroFab® for minimal or moderate crotalid envenomations, there were 7 events classified as early serum reactions and 5 events classified as late serum reactions, and none were serious (Table 2). In the clinical studies, serum reactions consisted mainly of urticaria and rash, and all patients recovered without sequelae.
6.2 Post-marketing Experience

The following adverse reactions have been identified during the post approval use of CroFab®. Because these reactions are reported voluntarily from a population of uncertain size, it is not always possible to reliably estimate their frequency or establish a causal relationship to product exposure:

- Acute allergic reactions including anaphylaxis or anaphylactoid type reactions during or shortly following CroFab® infusion, manifested by one or more of the following: anxiety, bronchospasm, chills, edema, fever, hypotension, pruritis, rash, urticaria, voice alteration, and/or wheezing
- Delayed allergic reaction manifested by fever, pruritis and/or rash
- Delayed or recurrent coagulopathy or thrombocytopenia
- Failure to achieve initial control
- Recurrent swelling refractory to treatment
- Thrombocytopenia refractory to treatment
- Prolonged hospitalization
- Bleeding
- Nausea
- Tremor
- Worsening eye sight
- Treatment failure resulting in death

A retrospective study of data collected by the Rocky Mountain Poison and Drug Center for post-marketing use of CroFab® was conducted (13.2).

- There were a total of 36 immediate adverse drug reactions reported in 6.1% (15/247) of patients in the post-marketing retrospective study, including one patient in the severely envenomated group (3.6%, n = 28) and 13 patients in the mild/moderate severity group (7.2%, n = 181) (not significantly different rates).
  - There were 11 immediate serious adverse events related to CroFab® administration reported in four patients. The events included two episodes each of hypotension and tongue swelling, and one episode each of chest discomfort, angioedema, bronchospasm, wheezing, tracheal edema, dyspnea, and lip swelling.
  - There were 22 immediate non-serious adverse events related to CroFab® administration reported in 12 patients. The events included four episodes each of rash and pruritis, three episodes of urticaria, and one episode each of tachycardia, tachypnea, erythema, swelling, hyperhidrosis, dizziness, headache, musculoskeletal chest pain, chills, feeling cold, and nervousness.

- Delayed hypersensitivity reactions were reported for two patients. In one patient the symptoms occurred 6 days post-dosing, were not serious, and described as hives, itching and epigastric pressure. In the second patient symptoms were not described in the medical records and were therefore not captured in this study.

- Recurrent coagulopathy developed in 5 severely envenomated patients and in 6 mild/moderate envenomated patients. In addition, 7 mild/moderate patients experienced delayed-onset coagulopathy. One severely envenomated patient with recurrent coagulopathy experienced medically significant bleeding.

Additional Published Clinical Studies Experience

From a literature review of nine publications on CroFab® containing patient exposure data, 15 of 313 (4.8%) patients receiving CroFab® experienced acute hypersensitivity reactions.

The most common signs and symptoms associated with these reactions were rash (10 patients) and wheezing (3 patients). Most reactions were mild, resolved after antihistamine therapy, and did not require discontinuation of antivenom therapy. No patient developed a life-threatening hypersensitivity reaction, required intubation, suffered lasting ill-effect, or died as a result of CroFab® administration.

Follow up data (minimum of six days after treatment) were available in 94 of the 313 patients and delayed hypersensitivity reactions were reported in 10 cases. The most common signs and symptoms of delayed hypersensitivity were rash (9 patients) and fever (3 patients). Most were mild and treated with antihistamines and steroids.

7 DRUG INTERACTIONS

Studies of drug interactions have not been conducted with CroFab®.

8 USE IN SPECIFIC POPULATIONS

8.1 Pregnancy

Pregnancy Category C. Animal reproduction studies have not been conducted with CroFab®. It is also not known whether CroFab® can cause fetal harm when administered to a pregnant woman or can affect reproduction capacity. CroFab® should be given to a pregnant woman only if clearly needed.

CroFab® contains mercury in the form of ethyl mercury from thimerosal (see Warnings and Precautions, Mercury (5.3)). Although there are limited toxicology data on ethyl mercury, high dose and acute exposures to methyl mercury have been associated with neurological and renal toxicities. Developing fetuses and very young children are most susceptible and therefore, at greater risk.

8.2 Nursing Mothers

It is not known whether CroFab® is excreted in human breast milk. Because many drugs are excreted in human milk, caution should be exercised when CroFab® is administered to a nursing woman.

8.3 Pediatric Use

Specific studies in pediatric patients have not been conducted. Limited clinical experience has not shown that a dosage adjustment for age should be made.

CroFab® contains mercury in the form of ethyl mercury from thimerosal (see Warnings and Precautions, Mercury (5.3)). Although there are limited toxicology data on ethyl mercury, high dose and acute exposures to methyl mercury have been associated with neurological and renal toxicities. Developing fetuses and very young children are most susceptible and therefore, at greater risk.

8.4 Geriatric Use

Specific studies in elderly patients have not been conducted.

<table>
<thead>
<tr>
<th>Table 2 Incidence of Early and Late Serum Reactions (Reactions Associated with CroFab® Infusion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Serum Reactions</td>
</tr>
<tr>
<td>Urticaria</td>
</tr>
<tr>
<td>Cough</td>
</tr>
<tr>
<td>Allergic reaction**</td>
</tr>
<tr>
<td>Late Serum Reactions</td>
</tr>
<tr>
<td>Rash</td>
</tr>
<tr>
<td>Pruritus</td>
</tr>
<tr>
<td>Urticaria</td>
</tr>
<tr>
<td>Serum sickness†</td>
</tr>
<tr>
<td>n=42*</td>
</tr>
</tbody>
</table>

* 6 of 42 patients experienced an adverse event associated with an early serum reaction and 4 experienced an adverse event associated with a late serum reaction. Two additional patients were considered to have a late serum reaction by the investigator, although no associated adverse event was reported.

** Allergic reaction consisted of urticaria, dyspnea and wheezing in 1 patient.

† Serum sickness consisted of severe rash and pruritus in 1 patient.
OVERDOSAGE
The maximum amount of CroFab® that can safely be administered in single or multiple doses has not been determined. Doses of up to 18 vials (approximately 13.5 g of protein) have been administered without any observed direct toxic effect.

DESCRIPTION
CroFab® [Crotalidae Polyvalent Immune Fab (Ovine)] is a sterile, nonpyrogenic, purified, lyophilized preparation of ovine Fab (monovalent) immunoglobulin fragments obtained from the blood of healthy sheep flocks immunized with one of the following North American snake venoms: Crotalus atrox (Western Diamondback rattlesnake), Crotalus adamanteus (Eastern Diamondback rattlesnake), Crotalus scutulatus (Mohave rattlesnake), and Agkistrodon piscivorus (Cottonmouth or Water Moccasin). To obtain the final antivenin product, the four different monospecific antivenins are mixed. Each monospecific antivenin is prepared by fractionating the immunoglobulin from the ovine serum, digesting it with papain, and isolating the venom specific Fab fragments on ion exchange and affinity chromatography columns.

CroFab® is standardized by its ability to neutralize the lethal action of each of the four venom immunogens following intravenous injection in mice. The potency of the product will vary from batch to batch; however, a minimum number of mouse LD50 neutralizing units against each of the four venoms is included in every vial of final product, as shown in Table 3.

The maximum amount of CroFab® included in every vial of final product, as shown in Table 3. The maximum amount of CroFab® is standardized by its ability to neutralize the lethal action of each of the four venom immunogens following intravenous injection in mice. The potency of the product will vary from batch to batch; however, a minimum number of mouse LD50 neutralizing units against each of the four venoms is included in every vial of final product, as shown in Table 3.

Table 3 Minimum Mouse LD50 Neutralizing Units1 for Each Venom Component

<table>
<thead>
<tr>
<th>Venom</th>
<th>Minimum Potency per Vial of CroFab®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crotalus atrox</td>
<td>≥1270</td>
</tr>
<tr>
<td>Crotalus adamanteus</td>
<td>≥420</td>
</tr>
<tr>
<td>Crotalus scutulatus</td>
<td>≥570</td>
</tr>
<tr>
<td>Agkistrodon piscivorus</td>
<td>≥780</td>
</tr>
</tbody>
</table>

1 One neutralizing unit is determined as the amount of the mixed monospecific Fab proteins necessary to neutralize one LD50 of each of the four venoms, where the LD50 is the amount of venom that would be lethal in 50% of mice.

2 As of 2008, the potency assay has been optimized for a new strain of mice, which has resulted in changes to the minimum mouse LD50 neutralizing units. These changes do not reflect any change in product potency, but only a different biological response of the mouse strain to the venom.

Each vial of CroFab® contains up to 1 g of total protein and sodium phosphate buffer consisting of dibasic sodium phosphate USP and sodium chloride USP. Thimerosal is used as a preservative in the manufacturing process, and as such, mercury is carried over into the final product at an amount no greater than 30 mcg per vial, which amounts to no more than 0.6 mcg of mercury per dose (based on the maximum dose of 18 vials used in clinical studies of CroFab®). The product is intended for intravenous administration after reconstitution with 18 mL of 0.9% Saline.

CLINICAL PHARMACOLOGY
11.1 Mechanism of Action
CroFab® is a venom-specific Fab fragment of immunoglobulin G (IgG) that works by binding and neutralizing venom toxins, facilitating their redistribution away from target tissues and their elimination from the body.

Pharmacokinetics
The pharmacokinetic study of CroFab® was not adequately performed. A limited number of samples were collected from three patients. Based on these data, estimates of elimination half-life were made. The elimination half life for total Fab ranged from approximately 12 to 23 hours. These limited pharmacokinetic estimates of half-life are augmented by data obtained with an analogous ovine Fab product produced by Protherics Inc. using a similar production process. In that study, 8 healthy subjects were given 1 mg of intravenous digoxin followed by an approximately equimolar neutralizing dose of 76 mg of digoxin immune Fab (ovine). Total Fab was shown to have a volume of distribution of 0.3 L/kg, a systemic clearance of 32 mL/min (approximately 0.4 mL/min/kg) and an elimination half-life of approximately 15 hours.

NONCLINICAL TOXICOLOGY
12.1 Carcinogenesis, Mutagenesis, Impairment of Fertility
Animal carcinogenicity and reproduction studies have not been conducted with CroFab®.

12.2 Animal Toxicology and/or Pharmacology
CroFab® was effective in neutralizing the venoms of 10 clinically important North American crotalid snakes in a murine lethality model (see Table 4) [1]. In addition, preliminary data from experiments in mice using whole IgG from the sheep immunized for CroFab® production suggest that CroFab® might possess antigenic cross-reactivity against the venoms of some Middle Eastern and North African snakes, however, there are no clinical data available to confirm these findings.

Table 4 Average ED50 Values for CroFab® in Mice

<table>
<thead>
<tr>
<th>Study Objective &amp; Design</th>
<th>Endpoint Measured</th>
<th>Major Findings and Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>To determine the cross-neutralizing ability of CroFab® to protect mice from the lethal effects of venom from clinically important species.</td>
<td>ED50 for each venom</td>
<td>(Note: Lower numbers represent increased potency against venoms listed)</td>
</tr>
<tr>
<td>Separate groups of mice were injected with increasing doses of CroFab® pre-mixed with two LD50 of each venom tested.</td>
<td></td>
<td>Challenge Venom ED50</td>
</tr>
<tr>
<td>C. atrox</td>
<td>3</td>
<td>C. atrox</td>
</tr>
<tr>
<td>C. adamanteus</td>
<td>18</td>
<td>C. adamanteus</td>
</tr>
<tr>
<td>C. scutulatus</td>
<td>18</td>
<td>C. scutulatus</td>
</tr>
<tr>
<td>A. piscivorus</td>
<td>4</td>
<td>A. piscivorus</td>
</tr>
<tr>
<td>C. h. atroxraceus</td>
<td>11</td>
<td>C. h. atroxraceus</td>
</tr>
<tr>
<td>C. v. helleri</td>
<td>6</td>
<td>C. v. helleri</td>
</tr>
<tr>
<td>C. m. molossus</td>
<td>5</td>
<td>C. m. molossus</td>
</tr>
<tr>
<td>A. c. contortrix</td>
<td>8</td>
<td>A. c. contortrix</td>
</tr>
<tr>
<td>S. m. barbouri</td>
<td>12</td>
<td>S. m. barbouri</td>
</tr>
<tr>
<td>C. h. horridus</td>
<td>6</td>
<td>C. h. horridus</td>
</tr>
</tbody>
</table>

Based on data from studies in mice, CroFab® has relatively good cross-protection against venoms not used in the immunization of flocks used to produce it. For C. v. helleri and C. m. molossus, higher doses may be required based on historical data.
13 CLINICAL STUDIES
No clinical studies have been conducted comparing CroFab® with other antivenins, therefore, no comparisons can be made between CroFab® and other antivenins.

13.1 Pre-marketing Studies
Two prospective clinical trials using CroFab® have been conducted. They were prospectively defined, open label, multi-center trials conducted in otherwise healthy patients 11 years of age or older who had suffered from minimal or moderate (as defined in Table 5) North American crotalid envenomation that showed evidence of progression. Progression was defined as the worsening of any evaluation parameter used in the grading of an envenomation: local injury, laboratory abnormality or symptoms and signs attributable to crotalid snake venom poisoning. Both clinical trials excluded patients with Copperhead envenomation.

Table 5 Definition of Minimal, Moderate, and Severe Envenomation in Clinical Studies of CroFab®

<table>
<thead>
<tr>
<th>Envenomation Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>Swelling, pain, and ecchymosis limited to the immediate bite site;</td>
</tr>
<tr>
<td></td>
<td>Systemic signs and symptoms absent;</td>
</tr>
<tr>
<td></td>
<td>Coagulation parameters normal with no clinical evidence of bleeding.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Swelling, pain, and ecchymosis involving less than a full extremity or, if</td>
</tr>
<tr>
<td></td>
<td>bite was sustained on the trunk, head or neck, extending less than 50 cm;</td>
</tr>
<tr>
<td></td>
<td>Systemic signs and symptoms may be present but not life threatening,</td>
</tr>
<tr>
<td></td>
<td>including but not limited to nausea, vomiting, oral paresthesia or unusual</td>
</tr>
<tr>
<td></td>
<td>tastes, mild hypotension (systolic blood pressure &gt;90 mmHg), mild</td>
</tr>
<tr>
<td></td>
<td>tachycardia (heart rate &lt;150), and tachypnea;</td>
</tr>
<tr>
<td></td>
<td>Coagulation parameters may be abnormal, but no clinical evidence of bleeding</td>
</tr>
<tr>
<td></td>
<td>present. Minor hematuria, gum bleeding and nosebleeds are allowed if they</td>
</tr>
<tr>
<td></td>
<td>are not considered severe in the investigator’s judgment.</td>
</tr>
<tr>
<td>Severe</td>
<td>Swelling, pain, and ecchymosis involving more than an entire extremity or</td>
</tr>
<tr>
<td></td>
<td>threatening the airway; Systemic signs and symptoms are markedly abnormal,</td>
</tr>
<tr>
<td></td>
<td>including severe alteration of mental status, severe hypotension, severe</td>
</tr>
<tr>
<td></td>
<td>tachycardia, tachypnea, or respiratory insufficiency; Coagulation parameters</td>
</tr>
<tr>
<td></td>
<td>are abnormal, with serious bleeding or severe threat of bleeding.</td>
</tr>
</tbody>
</table>

In both clinical studies, efficacy was determined using a Snakebite Severity Score (SSS) [2] (referred to as the efficacy score or ES in these clinical studies) and an investigator’s clinical assessment (ICA) of efficacy. The SSS (referred to as the ES) is a tool used to measure the severity of envenomation based on six body categories: local wound (e.g., pain, swelling and ecchymosis), pulmonary, cardiovascular, gastrointestinal, hematological, and nervous system effects. A higher score indicates worse symptoms. In a retrospective study using medical records of 108 snakebite victims [2], the SSS has been shown to correlate well with physicians' assessment of the patient's condition at presentation (Pearson correlation coefficient: r=0.63, p<0.0001) and when the patient's condition was at its worst (r=0.70, p=0.0001). In this study, the condition of 87/108 patients worsened during hospitalization. Changes in the physicians' assessment of condition correlated well with changes in SSS. CroFab® was required to prevent an increase in the ES in order to demonstrate efficacy.

The ICA was based on the investigator’s clinical judgment as to whether the patient had a:
- Clinical response (pre-treatment signs and symptoms of envenomation were arrested or improved after treatment)
- Partial response (signs and symptoms of envenomation worsened, but at a slower rate than expected after treatment)
- Non-response (the patient’s condition was not favorably affected by the treatment).

Safety was assessed by monitoring for early allergic events, such as anaphylaxis and early serum reactions during CroFab® infusion, and late events, such as late serum reactions.

Table 5: Summary of Patient Efficacy Scores for Scheduled and PRN Groups

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Scheduled Group (n=15) Efficacy Score</th>
<th>Mean ± SD</th>
<th>PRN Group (n=16) Efficacy Score</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4.0 ± 1.3</td>
<td></td>
<td>4.7 ± 2.5</td>
<td></td>
</tr>
<tr>
<td>End of Initial Control Antivenin Infusion(s)</td>
<td>3.2 ± 1.4</td>
<td></td>
<td>3.3 ± 1.3</td>
<td></td>
</tr>
<tr>
<td>1 hour after Initial Control achieved</td>
<td>3.1 ± 1.3</td>
<td></td>
<td>3.2 ± 0.9</td>
<td></td>
</tr>
<tr>
<td>6 hours after Initial Control achieved</td>
<td>2.6 ± 1.5</td>
<td></td>
<td>2.6 ± 1.3</td>
<td></td>
</tr>
<tr>
<td>12 hours after Initial Control achieved</td>
<td>2.4 ± 1.1**</td>
<td></td>
<td>2.4 ± 1.2**</td>
<td></td>
</tr>
</tbody>
</table>

* No change or a decline in the Efficacy Score was considered an indication of clinical response and a sign of efficacy.
** For both the Scheduled and the PRN Groups, differences in the Efficacy Score at the four post-baseline assessment times were statistically decreased from baseline by Friedman’s test (p < 0.001).
In published literature accounts of rattlesnake bites, it has been noted that a decrease in platelets can accompany moderately severe envenomation, which whole blood transfusions could not correct [3]. These platelet count decreases have been observed to last for many hours and often several days following the venomous bite [3, 4, 5]. In this clinical study, 6 patients had pre-dosing platelet counts below 100,000/mm³ (baseline average of 44,000/mm³). Of note, the platelet counts for all 6 patients increased to normal levels (average 209,000/mm³) at 1 hour following initial control dosing with CroFab® (see Figure 1).

**Figure 1** Graph of Platelet Counts from Baseline to 36 Hours for Patients with Counts <100,000/mm³ at Baseline (Study TAB002)

Although there was no significant difference in the decrease in ES between the two treatment groups, the data suggest that Scheduled dosing may provide better control of envenomation symptoms caused by the continued leaking of venom from depot sites. Scheduled patients experienced a lower incidence of coagulation abnormalities at follow up compared with PRN patients (see Table 7 and Figure 2). In addition, the need to administer additional CroFab® to patients in the PRN Group after initial control suggests that there is a continued need for antivenin for adequate treatment.

**Table 7** Lower Incidence of Recurrence of Coagulopathies at Follow-Up in Scheduled and PRN Dosing Groups

<table>
<thead>
<tr>
<th></th>
<th>Scheduled Group (n=14)* (percent of patients with abnormal values)^</th>
<th>PRN Group (n=16) (percent of patients with abnormal values)^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet</td>
<td>2/14 (14%)**</td>
<td>9/16 (56%)**</td>
</tr>
<tr>
<td>Fibrinogen</td>
<td>2/14 (14%)</td>
<td>7/16 (44%)</td>
</tr>
</tbody>
</table>

^ Numbers are expressed as percent of patients that had a follow-up platelet count that was less than the count at hospital discharge, or a fibrinogen level less than 50% of the level at hospital discharge.

* Follow-up data not available for one patient.

** Statistically significant difference, p=0.04 by Fisher’s Exact test.

13.2 Post-marketing Studies

Following marketing approval of CroFab®, a retrospective study was conducted to assess the efficacy of CroFab® in severe envenomation. This study was a multi-center retrospective chart review of medical records of snakebite patients treated with CroFab® and compared treatment and outcomes of severe envenomations to those of mild and moderate envenomations. The primary efficacy variable was severity of envenomation as determined by a 7-point severity score. Patients were classified as having mild, moderate, or severe envenomation based on their scores just prior to receiving antivenom. Those subjects with a severity score of 5 or 6 at the start of antivenom therapy were a priori defined as severe envenomations; those with a score of 3 or 4 were defined as moderate envenomations, and those with a score of 1 or 2 were defined as mild envenomations (see Table 5). A total of 247 patients of all severities were included in the study. Patients with enough data to determine baseline severity were included in the efficacy evaluation; this comprised a cohort of 209 patients, of which 28 were classified as severe.
Improvement in the severity score was observed in all 28 severely envenomated patients. Improvement was noted in every one of the severe venom effects studied, including limb pain and swelling, cardiovascular, respiratory, gastrointestinal and neurologic effects, as well as coagulopathy/defibrination syndrome, thrombocytopenia, and significant/spontaneous bleeding. The median dose of CroFab® administered to control these severe venom effects was 9.0 vials (median of 2.0 doses). Initial control of envenomation was achieved in 57% (16/28) of severely envenomated patients and 87% (158/181) of mild/moderate envenomated patients. In both groups failure to achieve initial control was most commonly attributable to persistent coagulopathy and/or thrombocytopenia, although medically significant bleeding has been reported (occurring in only 1 severe patient that did not reach initial control). All 12 severe patients who did not reach initial control received only one bolus dose of 4 to 6 vials to try to achieve initial control of envenomation. Of the 23 mild/moderate cases who did not reach initial control, 19 did not follow recommended dosing for number of doses and vials. Whether initial control could have been achieved with larger initial doses of antivenom cannot be determined from this retrospective study. All patients, whether they achieved initial control or not, experienced significant improvement of venom effects and decreased severity scores after receiving CroFab®. Among the patients with severe envenomation who did not achieve initial control, the median severity score improved from 5.0 (range: 5.0 – 6.0) before CroFab® administration to 2.0 (range: 1.0 – 4.0) at the last loading dose. No patient in this analysis had a severity score greater than 3.0 at the time of final clinical assessment.

14 REFERENCES


7. Baur X, Chen Z, Rozynk P, Dieter D, Raffat Heimsoth M. Cross reacting IgE antibodies recognizing latex allergens, including Hev b 1, as well as papain. Allergy 1995; 50(7):604 609.


15 HOW SUPPLIED/STORAGE AND HANDLING

CroFab® is supplied as a carton that contains 2 vials of product (diluent not included). Each vial of CroFab® contains up to 1 gram of lyophilized total protein and not less than the indicated number of mouse LD₅₀ neutralizing units:

<table>
<thead>
<tr>
<th>Snake Species Used for Antivenin Component</th>
<th>Minimum mouse LD₅₀ Units per vial</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. atrox (Western Diamondback rattlesnake)</td>
<td>1270</td>
</tr>
<tr>
<td>C. adamanteus (Eastern Diamondback rattlesnake)</td>
<td>420</td>
</tr>
<tr>
<td>C. scutulatus ( Mojave rattlesnake)</td>
<td>5570</td>
</tr>
<tr>
<td>A. piscivorus ( Cottonmouth or Water Moccasin)</td>
<td>780</td>
</tr>
</tbody>
</table>

• Store at 2°C to 8°C (36° to 46°F).
• Do not freeze.
• Use within 4 hours after reconstitution.

16 PATIENT COUNSELING INFORMATION

• Advise patients to contact their physician immediately if they experience unusual bruising or bleeding (e.g., nosebleeds, excessive bleeding after brushing teeth, the appearance of blood in stools or urine, excessive menstrual bleeding, petechiae, excessive bruising or persistent oozing from superficial injuries) after hospital discharge.
  • Such bruising or bleeding may occur for up to 1 week or longer following initial treatment.

• Advise patients to contact their physician immediately if they experience any signs and symptoms of delayed allergic reactions or serum sickness (e.g., rash, pruritus, urticaria) after hospital discharge.

Rx only

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West Conshohocken, PA 19428

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Revised March 2012 P11012C