Target Audience: Emergency Medicine Residents, Medical Students

Primary Learning Objectives:

1. Recognize signs, symptoms, and course of scorpion envenomation
2. Understand differential diagnosis for scorpion envenomation
3. Discuss the indications for antivenom
4. Discuss non-antivenom management options

Secondary Learning Objectives: detailed technical/behavioral goals, didactic points

1. Prevention of stings
2. Understand cost of treatment
3. Understand how to prepare and administer the current antivenom
4. Manage related symptoms

Critical actions checklist:

1. Obtain IV access
2. Recognize the envenomation
3. Determine the timing of the envenomation
4. Assess and perform focused exam
5. Treat with antivenom
6. Monitor the patient (place on continuous cardiac and respiratory monitoring)
7. Obtain labs

Environment:

1. Room Set Up – ED non-critical care area
    a. Pediatric Manikin Set Up – Mid or high fidelity simulator, simulated secretions
    b. Props – Standard ED equipment
2. Distractors – ED noise, terrified parents

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CASE SUMMARY

SYNOPSIS OF HISTORY/ Scenario Background

The setting is a rural emergency department.

Patient is a 3-year-old male without medical history brought to the emergency department by parents for agitation and foaming at the mouth. They are not sure what happened. He was playing outside in the early evening with his 7-year-old cousin. He was heard screaming and his parents attended to him immediately. At first he would only say "ouch, ouch" with pain in his right foot. Over the course of about 30 minutes he became agitated. The parents then put him in the car to drive to the ER. He began frothing during the 30-minute car trip.

If Asked:
Dad was stung by a scorpion a few times in the past. "Man those suckers hurt." No chemicals are present as this is not a working ranch.

Potential Complication:
He also works with some chemicals on their ranch including organophosphates but, "I keep those all locked up."

Potential Complication:
For an even more challenging case, they are not locked up and remove reference to pain from presentation…patient found agitated.

Potential Complication:
A history of methamphetamine use by parents can be elicited. This case should remain a scorpion envenomation treated successfully with antivenom.

ROS: the patient was well until today

PMHx: None
PSHx: None
Medications: None
SocHx: Alcohol in household but "put up;" Dad smokes cigars occasionally

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CRITICAL ACTIONS

1. Obtain IV access

Obtain IV access. May give 1 to 2 liters of NS for volume resuscitation if patient develops hypotension.
Cueing Guideline: The nurse may say, “Do you want an IV?” or “Would you like any fluids?” Alternatively, the nurse can mention the tachycardia.

2. Recognize envenomation

The examinee must elicit a history of scorpions in the area. Dad will admit to stings.

3. Determine the timing of the envenomation

Examinee should elicit timing. This is an acute case.
Cueing Guideline: The nurse asks the doctor about the approximate time that the envenomation occurred.

4. Treat with antivenom

Ask about any previous exposures to antivenom and allergies.
Cueing Guideline: Nurse can ask the doctor if the antivenom can cause allergic reactions prior to administration.

5. Place the patient on continuous cardiac and respiratory monitoring

6. Obtain appropriate labs

With a straightforward history, no labs are required to confirm the diagnosis. Screening labs including CBC, CMP, UDS, UA, and CK can be obtained to exclude or confirm sequelae. All will be normal.
Cueing Guideline: The nurse can ask if the doctor would like any labs or any levels on the patient.

Critical Actions Checklist[1]

Resident Name	
Case Description	

Skills measured **Core competencies: PC** Patient care, **MK** Medical knowledge, **IC** Interpersonal and communication skills **P** Professionalism, **PB** Practice-based learning and improvement **SB** Systems-based practice	**Very Unacceptable**		**Unacceptable**		**Acceptable**		**Very Acceptable**	
Data Acquisition (D) PC MK I	1	2	3	4	5	6	7	8
Problem Solving (S) PC MK PB	1	2	3	4	5	6	7	8
Patient Management (M) PC MK IC P PB SB	1	2	3	4	5	6	7	8
Resource Utilization (R) PC PB SB	1	2	3	4	5	6	7	8
Health Care Provided (H) PC SB	1	2	3	4	5	6	7	8
Interpersonal Relations (I) IC P	1	2	3	4	5	6	7	8
Comprehension of Pathophysiology (P) MK PB	1	2	3	4	5	6	7	8
Clinical Competence (C) PC MK IC P PB SB	1	2	3	4	5	6	7	8

Critical Actions

Yes	**No**		**Comments:**
		Obtain IV access	
		Recognize envenomation	
		Determine the timing of the envenomation	
		Treat with antivenom	
		Place the patient on continuous cardiac and respiratory monitoring)	
		Obtain appropriate diagnostic labs	

Yes	**No**	
		Dangerous actions

[1] Modified ABEM Oral Certification Examination checklist and scoresheet

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HISTORY

You are called to see a 3-year-old male toddler. He is agitated and foaming at the mouth.

Chief Complaint: agitation

Past Medical Hx: none

Past Surgical Hx: none

ROS: He was well until today

PHYSICAL EXAM

General Appearance: Agitated, inconsolable

Vital Signs: **BP: 125/75 mmHg P: 145/minute R: 35/minute T: 38.1C (100.6F) POx: 94% (room air)**

Skin: Mildly diaphoretic

HEENT: Pupils: 5mm reactive. Producing foamy white oral secretions. **IF ASKED:** Ocular movements: Roving movement.

Lungs: Tachypnea; mildly increased work of breathing. Mild crackles bilaterally. **AT FACULTY DISCRETION:** Can be severe crackles and marked increased work of breathing for more challenging case

CV: Tachycardic

GI: Agitation prevents good exam. No apparent tenderness

GU: Normal male external exam

MSK: No deformities or pain. Right foot/leg: No erythema, edema, discharge, deformity. Full passive range of motion. Active ROM appears grossly normal. Dorsalis pedis 2+. Sensation is difficult to assess due to agitation

Neuro: Agitated, not following commands. Myoclonic jerks

Required Actions

- Perform primary survey and assessment
- Provide initial stabilization measures and supportive care for ABCDs
- Place patient with continuous cardiac, hemodynamic, and respiratory monitoring

Branch Point

- **IF INITIAL STABILIZATION MEASURES ARE NOT PERFORMED WITHIN THE FIRST TWO MINUTES,** tachycardia and agitation worsen.
- **IF IV NORMAL SALINE BOLUSES ARE PROVIDED,** tachycardia improves.
- **IF IV NORMAL SALINE BOLUSES ARE NOT PROVIDED,** tachycardia and blood pressure worsen (**AT FACULTY DISCRETION,** patient may become hypotensive as the case progresses).
- **IF BENZODIAZEPINES ARE ADMINISTERED,** the patient's agitation improves.
- **IF POISON CENTER IS CALLED,** recommendation for antivenom administration is made.

CASE CONTINUATION

- Respiratory (mild hypoxia) and cardiovascular status (tachycardia) improve with supportive measures (supplemental oxygen), IV fluid administration and benzodiazepines.
- Results of all diagnostic studies should be provided by this time.
- Antivenom therapy ready for administration as case progresses and if Poison Center consulted.

Required Actions

- Administer at least 3 vials of scorpion antivenom (Anascorp®; equine-derived immunoglobulin) over 1 hour
- Arrange for admission (or transfer) to an appropriate pediatric intensive care unit for continued observation and serial reassessments.

Branch Point

- **IF PARENTS ARE ASKED ABOUT ALLERGIES,** parents reports that the patient has none, and antivenom should be started.

Required Actions

- Admit to an inpatient bed (PICU **– OR –** other bed based on institutional policy **– OR –** transfer to an appropriate tertiary pediatric facility)

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STIMULUS INVENTORY

#1 Complete blood count

#2 Basic metabolic panel

#3 Urinalysis

#4 Liver function tests

#5 ECG

#6 CXR

#7 Toxicology / Urine drug screen

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LAB DATA & IMAGING RESULTS

Stimulus #1	
Complete Blood Count (CBC)	
WBC	14,500/mm^3
Hemoglobin	13.2 g/dL
Hematocrit	40%
Platelets	239,000/mm^3
Differential	
PMNLs / Bands	45% / 1%
Lymphocytes	55%
Monocytes	2%
Eosinophils	1%

Stimulus #2	
Basic Metabolic Profile (BMP)	
Sodium	145mEq/L
Potassium	3.6mEq/L
Chloride	109 mEq/L
Bicarbonate	18 mEq/L
Glucose	82 mg/dL
BUN	17 mg/dL
Creatinine	1.0 mg/dL

Stimulus #3	
Urinalysis	
Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Negative
Leuk. Esterase	Negative
Nitrites	Negative
WBC/ RBC	4/hpf and 3/hpf
Other	Amorphous crystals, Squamous epithelial cells

Stimulus #4	
Liver Function Tests	
AST	49 U/L
ALT	32 U/L
Alk Phos	110 U/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

Stimulus #5	
ECG	Sinus tachycardia

Stimulus #6	
CXR	

Stimulus #7	
Toxicology	
Salicylate	Undetectable
Acetaminophen	Undetectable
Ethanol	Undetectable
Urine drug screen	
Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Negative
Opiates	Negative
TCAs	Negative
THC	Negative

Stimulus #1

Complete Blood Count (CBC)

WBC	14,500/mm^3
Hemoglobin	13.2 g/dL
Hematocrit	40%
Platelets	239,000/mm^3
Differential	
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Stimulus #2

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Creatinine	1.0 mg/dL

Stimulus #3

Urinalysis

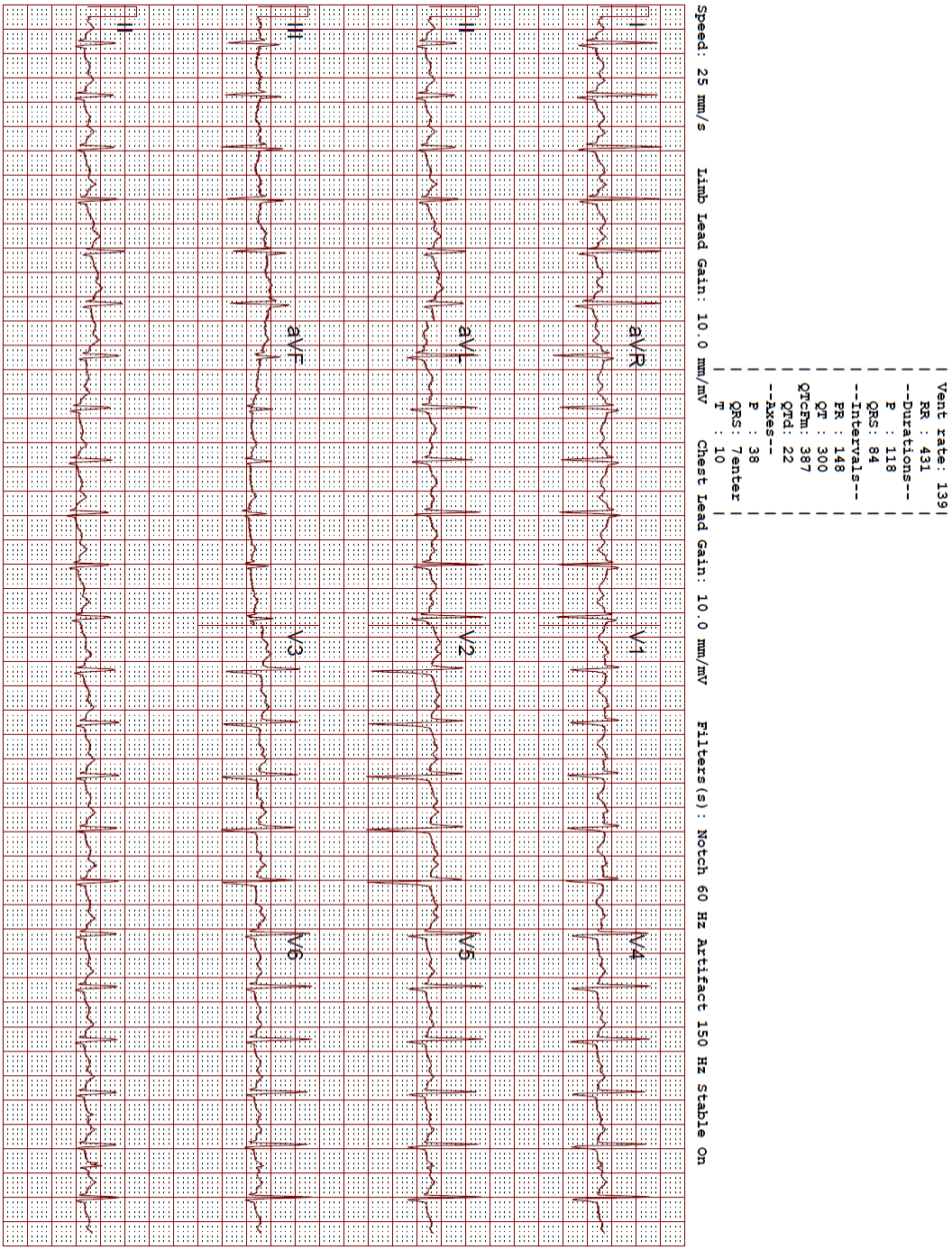
Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Negative
Leuk. Esterase	Negative
Nitrites	Negative
WBC/ RBC	4/hpf and 3/hpf
Other	Amorphous crystals, Squamous epithelial cells

Stimulus #4

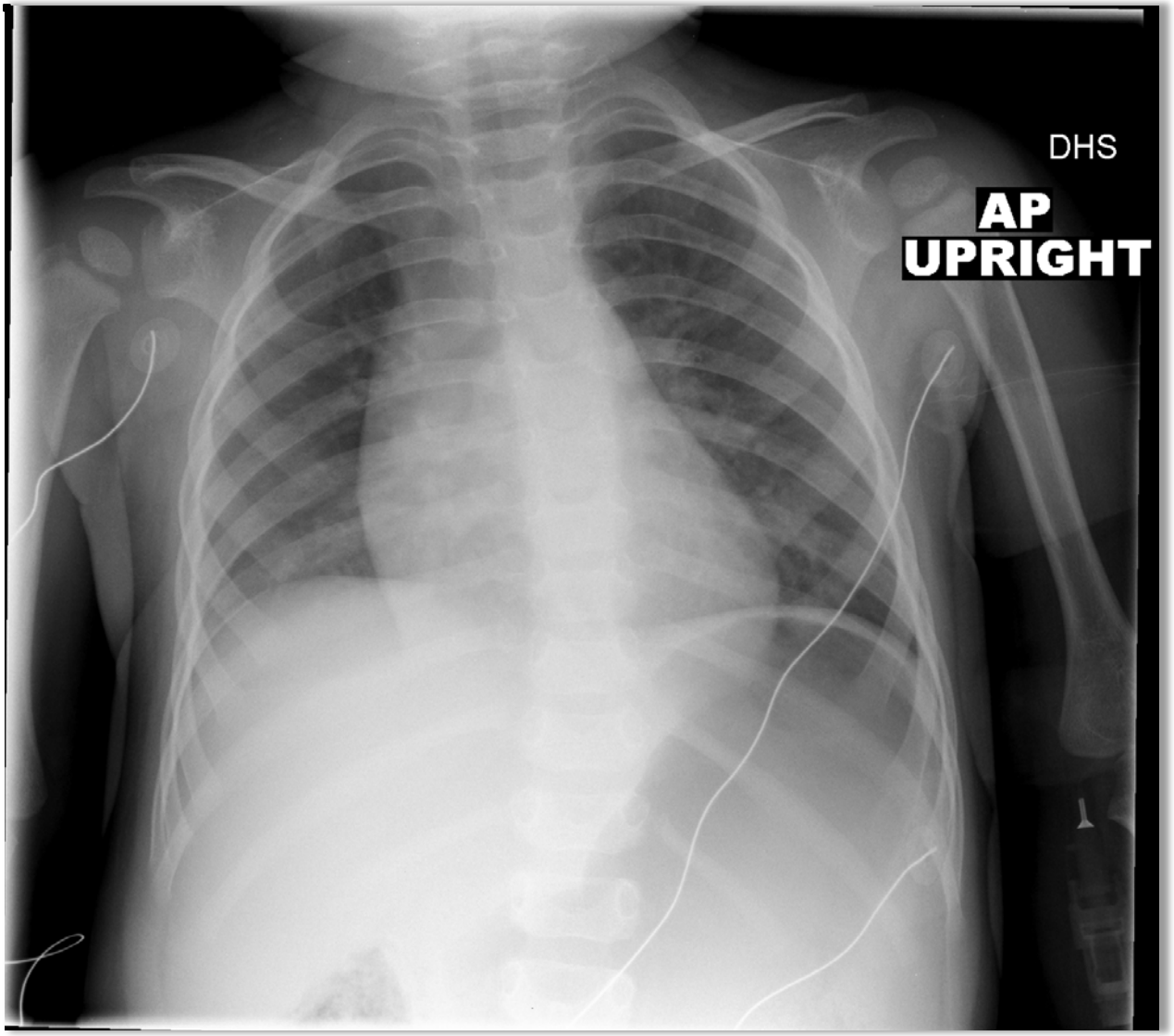
Liver Function Tests

AST	49 U/L
ALT	32 U/L
Alk Phos	110 U/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

Stimulus #5
ECG



Stimulus #6
CXR



Stimulus #7

Toxicology

Salicylate	Undetectable
Acetaminophen	Undetectable
Ethanol	Undetectable

Urine drug screen

Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Negative
Opiates	Negative
TCAs	Negative
THC	Negative

Debriefing Materials – *Centruroides* Envenomation

Sources of Exposure:

- There are many scorpion species in the world, but in the United States the only medically important species are the *Centruroides*. In particular the Arizona Bark Scorpion or *C. sculpturatus* is responsible for numerous symptomatic stings throughout the deserts of Arizona. There are reports of stings in Southern Utah, Southern New Mexico, and Southern Nevada.
- Scorpions are difficult to distinguish

Pathophysiology:

- Scorpion venom is a complex mixture of proteins including phospholipases, hyaluronidases, acetylcholinesterase, and neurotoxins
- The neurotoxins are Na^+ channel agonists that affect the neuromuscular junction, the sympathetic nervous system, and the parasympathetic nervous system

Severity of Sting:

- Scorpion stings can be roughly graded as follows

TABLE 118–6.
Envenomation Gradation for *Centruroides exilicauda* (Bark Scorpion)

Grade	*Signs and Symptoms*
I	Site of envenomation
	Pain and/or paresthesias
	Positive tap test (severe pain increase with touch or percussion)
II	Grade I in addition to
	Pain and paresthesias remote from sting site (eg, paresthesias moving up an extremity, perioral "numbness")
III	One of the following:
	Somatic skeletal neuromuscular dysfunction: jerking of extremity(ies), restlessness, severe involuntary shaking and jerking, which may be mistaken for seizures
	Cranial nerve dysfunction: blurred vision, wandering eye movements, hypersalivation, trouble swallowing, tongue fasciculation, upper airway dysfunction, slurred speech
IV	Both cranial nerve dysfunction and somatic skeletal neuromuscular dysfunction

From Goldfrank's 10e, Table 118-6

Organ System Effects:

- Pulmonary:
  - Bronchorrhea
  - Hypoxia
- Cardiovascular:
  - Tachycardia, Hypotension
- Neurologic:
  - Agitation
  - Roving eye movement
  - Myoclonic jerks
- Gastrointestinal:
  - Nausea and vomiting
- Dermatologic:
  - Diaphoresis

Diagnostic Testing:

- In obvious cases of envenomation, laboratory studies are not necessary.
- In less clear situations workup should be directed to sepsis, seizures, and other toxic substances such as organophosphate, amphetamines, sympathomimetics.

Treatment:

- Antivenom
  - At the time of this writing, the only available antivenom is Anascorp ®
  - In clinical trials Anascorp was very effective in resolving the effects of severe envenomation (grade III/IV).
  - Anascorp is an equine-derived Fab_2 immunoglobulin. As a foreign protein, severe reactions including anaphylaxis may occur but appear to be very rare.
  - Dosing
    - See package insert for most recent information
    - Loading
      - 3 vials reconstituted with normal saline
      - Placed in 50mL NS bag
      - Infuse over 10 minutes
    - Rebolus
      - If symptoms have not resolved at 1 hour
      - Repeat 1 vial infusion
      - Rebolus may be repeated once for total of 5 vials
  - Expense
    - Anascorp is an expensive medication for a complex variety of reasons with wholesale costs for Anascorp at ~$3800 per vial. At a minimum of 3 vials, this equates to ~$11,500 wholesale cost to the hospital which is then marked up accordingly. Typical markups are 2-3 times the wholesale cost. As such its use should be restricted to severe envenomation where it can prevent hospitalization.
    - The average number of vials required to resolve symptoms is ~4. Loading with less than 3 vials delays care.

- Non-antivenom
    - If Anascorp is not available, benzodiazepines and opioids may be used. Intubation may be required in severe envenomation
    - Care must be taken if benzodiazepines and opioids are used in conjunction with Anascorp as the resolution of symptoms may leave these agents unopposed resulting in respiratory depression
- Adjuvant treatments
    - For secretion
        - Glycopyrrolate IV
        - Ipratropium inhaled

Differential Diagnosis

- Sympathomimetics
    - Methamphetamine was found in three cases of "failed" antivenom treatment in children suspected of scorpion envenomation
- Sepsis
- Organophosphates
- Seizure disorder

Consultations:

- Consult the regional poison center or a local medical toxicologist for additional information and patient care recommendations.

Disposition:

- Observe for 4-6 hours after resolution of symptoms

Take-Home Points:

- In the United States, medically important scorpion envenomation is limited to the South-West and Arizona in-particular
- Anascorp is effective but expensive
- Benzodiazepines and opioids are an option but should be used with caution
- Methamphetamine can have similar presentation

References:

1. Hoffman, Howland, et al, Goldfrank's Toxicologic Emergencies, 10e, McGraw Hill.
2. Anascorp® package insert, http://www.fda.gov/ucm/groups/fdagov-public/@fdagov-biogen/documents/document/ucm266725.pdf, Accessed on 6/24/16