

Target Audience: Emergency Medicine Residents (junior and senior level postgraduate learners), Medical Students

Primary Learning Objectives:

1. Recognize clinical signs of sympathomimetic toxicity
2. Recognize life-threatening hyperthermia
3. Demonstrate the use and titration of benzodiazepines in controlling sympathomimetic toxidrome
4. Demonstrate the early institution of rapid cooling measures with continuous rectal temperature monitoring and cool mist/fan or ice bath.

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

1. Demonstrate professionalism and communication skills when consulting the intensive care unit (ICU) and working with ED nurse
2. Direct proper disposition/appropriate consultation

Critical actions checklist:

1. Perform primary survey
2. Obtain point-of-care glucose
3. Order ECG
4. Administer IV crystalloid fluids
5. Administer benzodiazepines
6. Initiate cooling therapies
7. Consult Poison Center/Toxicologist
8. Admit to the MICU

Environment: Emergency Department treatment area

Mannequin set up: Simulator mannequin, no moulage, on a stretcher or hospital bed. Mannequin should be male.

Props:

To be displayed on plasma screen/ computer screen or printed out on handouts in scenario room when asked for/return from lab:

- Images
 - ECG with sinus tachycardia
 - Radiology read of normal head CT
 - Radiology preliminary read of normal chest x-ray (CXR)
- Labs
 - CBC
 - Basic Metabolic Panel / Liver Function Tests
 - Troponin I
 - CK
 - Urinalysis
 - Lactic Acid
 - Urine Tox Screen

Available in the treatment room:

- Basic airway and code cart

- IVF (NS and D5W), D5NS or D5LR labeled liter bags
- Ice bags
- Fan
- Cooling blanket

Distractor: none

Actors:

- Paramedics are able to provide information about the scene, including drug paraphernalia used to smoke cocaine, but only if specifically asked.
- Co-worker. This may be an optional person available to provide additional information either in person or via phone.
- Patient voice is male. Patient is moaning unintelligibly.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Poison control available via “phone consultation.”
- ICU physician can be available via “phone consultation.”

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CASE SUMMARY

SYNOPSIS OF HISTORY/ Scenario Background

45 year-old male found unresponsive in his office. Patient works at a bank downtown. According to his co-worker, he appeared healthy when arriving to work. He had gone to lunch, returned to the office, and had been working alone for several hours when he was found collapsed on his desk. His medical history is unknown.

CC: Unresponsive

PMH: Unknown

Meds: Unknown

Allergies: Unknown but presumed none

Family Hx: Unknown

Social Hx: Unknown

SYNOPSIS OF PHYSICAL

Patient is moaning unintelligibly and flailing all extremities (Nurse may cue this by stating, "I need some help to control this guy!" "He's going to fall off the bed!")

Vital Signs: **BP: 197/120 mmHg P: 125/minute R: 24/minute T: 41C (105.8F)**
POx: 98% (FiO₂=0.21)

Eyes: Pupils mydriatic, equal

Heart: Tachycardia, no murmurs

Lungs: Equal bilaterally, clear to auscultation

Abdomen: Bowel sounds normal

Neurologic: Moaning unintelligibly, flailing all extremities, spontaneously opens eyes

Skin: Flushed, diaphoretic (If your mannequin is not capable of diaphoresis, this can be simulated by spraying the mannequin with water prior to starting the scenario)

CASE CONTINUATION (see below, and FLOW DIAGRAM)

Required Actions within the First Two Minutes

- Establish safety net (IV, oxygen, cardiac monitor, two large bore IVs, draw blood for labs)
- A/B – Assess airway and breathing; may provide supplemental oxygen
- C – Cardiac monitor and ECG; peripheral venous access and 2 L NS IV bolus; diagnostics should be ordered at this time
- D – Point-of-care glucose obtained; benzodiazepine administration for agitation
- E – Initial cooling measures should be started at this time

Branch Points

- **IF NO INTERVENTION OCCURS**, then the patient's tachycardia, hypertension, and agitation worsen (see **FLOW DIAGRAM**).
- **IF TWO OR MORE DOSES OF BENZODIAZEPINES ARE ADMINISTERED**, then the patient's agitation will improve (see **FLOW DIAGRAM**). Patient will describe a feeling of "bugs crawling under the skin."
- **AT FACULTY DISCRETION**, to make this case more difficult for senior learners, the patient becomes hypoxic after benzodiazepines are given and now requires intubation.

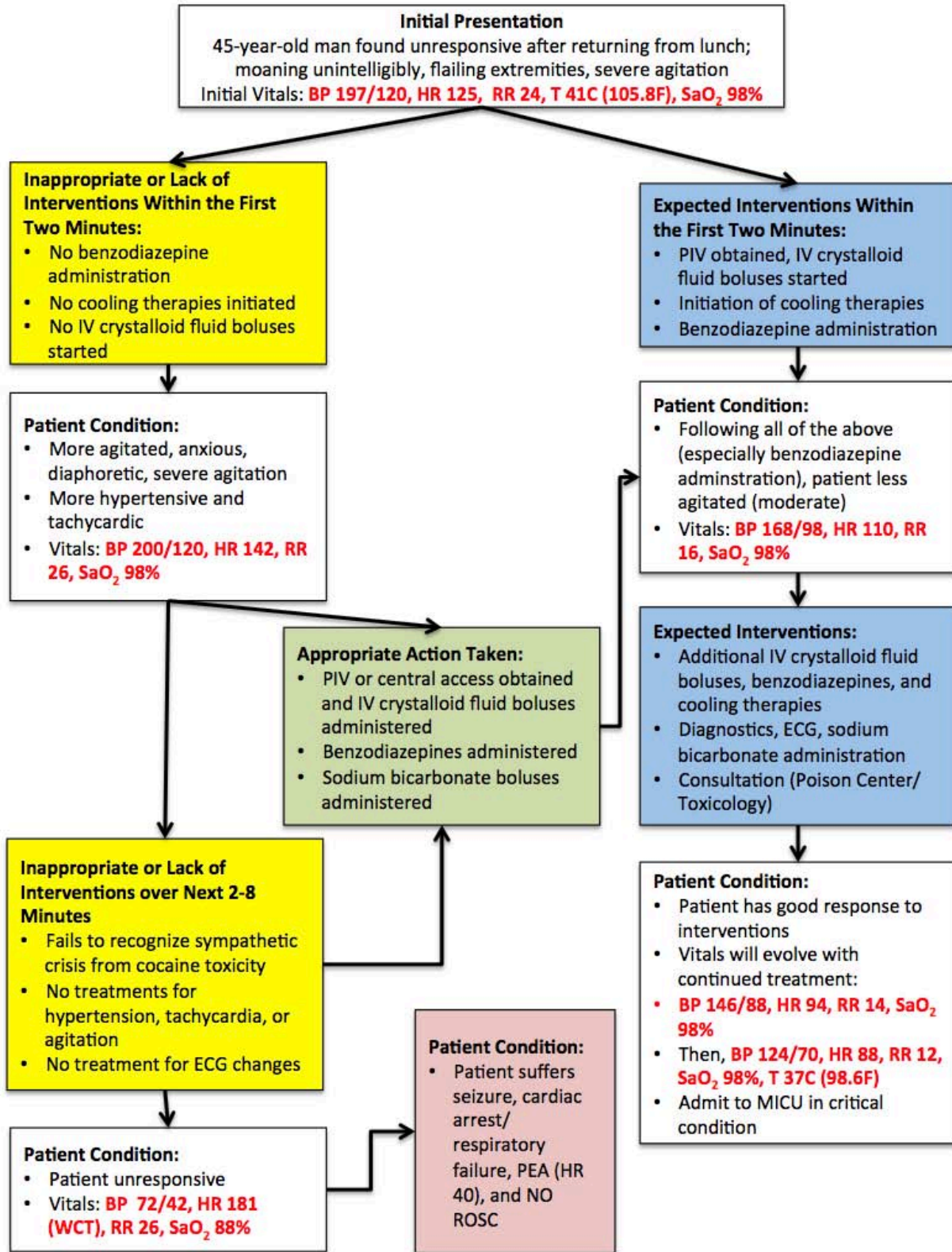
Required Actions over the Next Several Minutes

- Diagnostics return, and sympathetic toxidrome from cocaine toxicity should be considered by this time
- Multiple fluid boluses and doses of benzodiazepines should be provided over this time period for agitation, tachycardia, and hypertension
- Consultation with the MICU and Poison Center/Toxicologist should be considered at this time

Branch Points

- **IF TWO OR MORE DOSES OF BENZODIAZEPINES ARE NOT ADMINISTERED**, then the patient will clinically worsen over 10 minutes until he develops a wide-complex tachycardia.
- **IF THE PATIENT DEVELOPS WIDE-COMPLEX TACHYCARDIA**, bicarbonate and benzodiazepines should be administered.
- **IF DEFIBRILLATION IS PERFORMED**, the wide-complex tachycardia will not convert.

Timeline and Branch Points for This Case



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CRITICAL ACTIONS

1. Perform primary survey

Perform primary survey. Participant should recognize sympathomimetic toxidrome and differentiate it from the anticholinergic toxidrome (pupils, bladder, and skin).

Cueing Guideline: Nurse can ask how the participant wants to begin evaluating the patient.

2. Obtain point-of-care glucose

Obtain point-of-care glucose. Alternatively, the participant may select to administer empiric dextrose IV for suspected hypoglycemia.

Cueing Guideline: The nurse may say, "We have a line in place. Would you like anything to reverse this patient's condition?"

3. Obtain ECG

Order and obtain ECG. The participant should note the findings consistent with sympathetic stimulation.

Cueing Guideline: The nurse can mention that the rhythm looks abnormal on the monitor.

4. Administer IV crystalloid fluid boluses

To meet this critical action, the participant must have one or more peripheral venous catheters inserted and start IV crystalloid fluid boluses.

Cueing Guideline: The nurse can ask if IV fluid boluses are wanted.

5. Administer benzodiazepines

Administer benzodiazepines.

Cueing Guideline: The nurse may ask if the doctor can do anything for the patient's tachycardia and other symptoms.

6. Initiate cooling therapies

Initiate cooling therapies. This should include passive cooling therapies, but will not likely require active measures.

Cueing Guideline: The nurse may ask if the doctor can do anything for the patient's tachycardia, diaphoresis, and warm skin.

7. Consult Poison Center/Toxicologist

The Poison Center or Toxicology Service should be consulted for further management recommendations.

Cueing Guideline: Nurse can ask if the doctor has called the Poison Center/Toxicologist yet.

8. Admit to the MICU

Admit to the MICU for definitive care. Patient will not be stable for any other destination (e.g. telemetry or floor unit). Any attempt to admit elsewhere will be blocked by accepting physician.

Cueing Guideline: The nurse can ask the doctor if anyone has called the intensivist to arrange for a definitive disposition decision.

Critical Actions Checklist¹

Resident Name								
Case Description								
Skills measured <small>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</small>	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:			
		Perform primary survey						
		Obtain point-of-care glucose						
		Obtain ECG						
		Administer IV crystalloid fluid boluses						
		Administer benzodiazepines						
		Initiate cooling therapies						
		Consult Poison Center/Toxicologist			Yes	No		
		Admit to the MICU			<input type="checkbox"/>	<input type="checkbox"/>	Dangerous actions	

¹ Modified ABEM Oral Certification Examination checklist and scoresheet

For Examiner Only

STIMULUS INVENTORY

- #1 Complete blood count
- #2 Basic metabolic panel
- #3 Urinalysis
- #4 Liver function tests
- #5 Venous blood gas
- #6 Cardiac enzymes
- #7 Toxicology
- #8 Radiology (CXR, CT head)
- #9 Lactate
- #10 ECG

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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	45%
Lymphocytes	55%
Monocytes	2%
Eosinophils	1%

Stimulus #2	
Basic Metabolic Panel (BMP)	
Sodium	145 mEq/L
Potassium	3.6 mEq/L
Chloride	109 mEq/L
Bicarbonate	16 mEq/L
Glucose	150 mg/dL
BUN	17 mg/dL
Creatinine	1.2 mg/dL

Stimulus #3	
Urinalysis	
Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Trace
Leuk. Esterase	Negative
Nitrites	Negative
WBC	3/hpf
RBC	2/hpf

Stimulus #4	
Liver Function Tests	
AST	37 U/L
ALT	28 U/L
T. Bilirubin	1.1 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL
Protein	7 mg/dL

Stimulus #5	
Venous Blood Gas	
pH	7.32
pCO ₂	40
pO ₂	45
HCO ₃	14 mEq/L
O ₂ saturation	70%

Stimulus #6	
Cardiac Enzymes	
Troponin	< 0.01 ng/mL
CPK	1000 U/L

Stimulus #7	
Toxicology	
Salicylate	< 4 mg/dL
Acetaminophen	< 10 mcg/mL
Ethanol	Undetectable
Urine drug screen	
Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Positive
Opiates	Negative
TCA's	Negative
THC	Negative

Stimulus #8	
Radiology	
CXR	Normal
CT head	Normal

Stimulus #9	
Lactate	
Value	3 mmol/L

Stimulus #10	
ECG Sinus tachycardia, first-degree AVB (P waves hidden in the T waves, best seen in V1-2). Broad QRS complexes. Widened terminal 40 msec in aVR	

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	45%
Lymphocytes	55%
Monocytes	2%
Eosinophils	1%

Stimulus #2**Basic Metabolic Panel (BMP)**

Sodium	145 mEq/L
Potassium	3.6 mEq/L
Chloride	109 mEq/L
Bicarbonate	16 mEq/L
Glucose	150 mg/dL
BUN	17 mg/dL
Creatinine	1.2 mg/dL

Stimulus #3**Urinalysis**

Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Trace
Leuk. Esterase	Negative
Nitrites	Negative
WBC	3/hpf
RBC	2/hpf

Stimulus #4**Liver Function Tests**

AST	37 U/L
ALT	28 U/L
T. Bilirubin	1.1 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL
Protein	7 mg/dL

Stimulus #5**Venous Blood Gas**

pH	7.32
pCO ₂	40
pO ₂	45
HCO ₃	14 mEq/L
O ₂ saturation	70%

Stimulus #6**Cardiac Enzymes**

Troponin	< 0.01 ng/mL
CPK	1000 U/L

Stimulus #7**Toxicology**

Salicylate	< 4 mg/dL
Acetaminophen	< 10 mcg/mL
Ethanol	Undetectable
Urine drug screen	
Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Positive
Opiates	Negative
TCAs	Negative
THC	Negative

Stimulus #8
Radiology

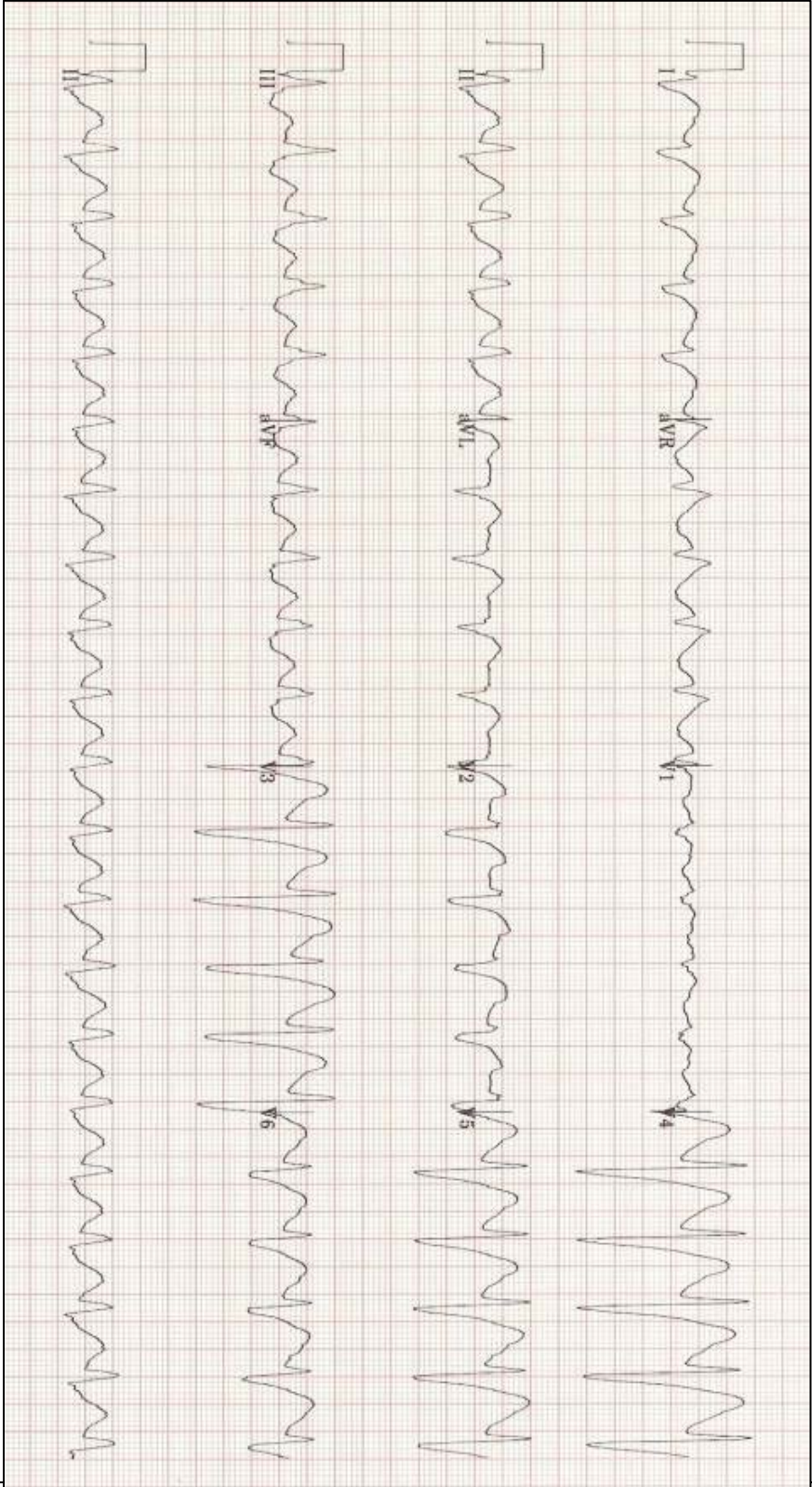
CXR	Normal
CT head	Normal

Stimulus #9

Lactate

Value	3 mmol/L
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Stimulus #10



Debriefing Materials – Cocaine Overdose

Debriefing Plan

Plan for approximately 10 minutes for discussion

Potential questions for discussion

- What is cocaine and what are its mechanisms of action?
- What are the characteristic ECG findings of cocaine overdose?
- What is the general emergency management of an overdose?
- What is the specific treatment for cocaine overdose?
- What are the expected physical exam findings in cocaine overdose?
- What are potential clinical effects of cocaine overdose?

Pathophysiology

Cocaine is a Type IC antidysrhythmic and inhibits reuptake of biogenic amines (dopamine, norepinephrine and serotonin) causing several physiologic effects:

- Prolongs Phase 0 of cardiac depolarization by blocking fast sodium channels→ ventricular tachycardia, QRS widening, Brugada pattern
- Inhibits reuptake of biogenic amines→ prolongation of dopamine, norepinephrine, and serotonin in neuromuscular junction→ euphoria (sometimes paranoia or agitation) and sympathomimetic findings (increased contractility, vasoconstriction)
- Hyperthermia results from muscular heat production due to agitation and vasoconstriction

Clinical Features

- Altered mental status leading to states of euphoria, agitation, paranoia, and seizures
- Pupils are mydriatic
- Cardiovascular effects
 - Sinus tachycardia
 - Ventricular tachycardia
 - Widened QRS
 - Brugada pattern
 - Elevated blood pressure
- Elevated temperature: hyperthermia is the most common cause of death in cocaine overdose
- Skin is diaphoretic

Diagnosis

- Positive cocaine in urine toxicology screen with clinical symptoms and characteristic ECG findings

Management

- Benzodiazepines are first line therapy. Midazolam may be preferred because of its rapid onset and brief duration of action (like cocaine)
 - Administer 1-2 mg IV midazolam, repeating doses every 3-5 minutes if agitation continues (caution with signs of respiratory depression)
- Treat hyperthermia aggressively
 - Intubate and paralyze (don't use succinylcholine as it competes with cocaine for plasma cholinesterase)

- Cool with fans or ice
- Reduce temperature below 40.5 within 30 minutes
- Cocaine associated ventricular tachycardia. Cocaine is a sodium channel blocker.
 - Sodium bicarbonate therapy – 1mEq/kg is first line therapy (also narrows widened QRS, probably by providing a sodium load to overcome the sodium channel blockade of cocaine)
 - Lidocaine (Class IB), second line therapy, competes with IA blockers for the sodium channel but does not cause channel dysfunction.

Selected Reading for Learners

1. Hoffman R. S., Prosser J. M. "Chapter 76. Cocaine" (Chapter). Lewis S. Nelson, Neal A Lewin, Mary Ann Howland, Robert S. Hoffman, Lewis R. Goldfrank, Neal E. Flomenbaum: Goldfrank's Toxicologic Emergencies, 9e:
<http://www.accessemergencymedicine.com/content.aspx?aID=6521068>
2. Haynes, John F. Medical management of adolescent drug overdose. *Adoles Clin N Am.* 2006; 17 (2): 353-79.
3. Tricyclic overdose (Sodium-Channel Blocker Toxicity). (2016). Accessed: May 25, 2016: <http://lifeinthefastlane.com/ecg-library/basics/tca-overdose>.