

SIMULATION

Cocaine-induced Myocardial Infarction and Pulmonary Edema

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ABSTRACT:

Audience: The target audience for this simulation is emergency medicine residents and medical students at any level of training.

Introduction: There are up to 1.6 million cocaine users reported in the United States (US) as of 2010.¹ Cocaine accounts for 40% of drug-related deaths and up to 40% of US emergency department visits for illicit drug use.² Cocaine is a drug of abuse that can have serious complications that the emergency physician should be prepared to manage. In small quantities, it may present with only mild symptoms; however, abuse in large quantities can result in cardiopulmonary complications including myocardial infarction and pulmonary edema.³ Toxicology simulations can provide a safe and educational environment in which to learn the acute management and treatment of conditions such as cocaine overdose.

Objectives: By the end of this simulation session, the learners will be able to: 1) Determine appropriate diagnostics in a patient with likely cocaine toxicity. 2) Identify and manage respiratory failure. 3) Identify and manage a ST-elevation myocardial infarction (STEMI) and pulmonary edema. 4) Identify and manage cocaine toxicity with benzodiazepines. 5) Determine appropriate disposition of the patient to the cardiac catheterization lab and an intensive care unit (ICU). 6) Demonstrate effective communication and teamwork during resuscitation of a critically ill patient.

Method: This simulation is designed to be performed using a high-fidelity simulation mannequin. However, it could be adjusted for low- or moderate-fidelity simulation, or as an oral board case. At the end of the simulation instructors should debrief, provide feedback, and review key points for reinforcement.

Topics: Simulation, cocaine, toxicology, myocardial infarction, pulmonary edema, altered mental status.



USER GUIDE

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Learner Audience:

Medical Students, Interns, Junior Residents, Senior Residents, Pharmacy Students/Residents

Time Required for Implementation:

Instructor Preparation: 30 minutes

Time for case: 15 minutes

Time for debriefing: 10 minutes

Recommended Number of Learners per Instructor:

4

Topics:

Simulation, cocaine, toxicology, myocardial infarction, pulmonary edema, altered mental status.

Objectives:

By the end of this simulation session, the learner will be able to:

1. Determine appropriate diagnostics in a patient with likely cocaine toxicity.
2. Identify and manage respiratory failure.
3. Identify and manage a STEMI and pulmonary edema.
4. Identify and manage cocaine toxicity with benzodiazepines.
5. Determine appropriate disposition of the patient to the cardiac catheterization lab and a critical care unit.
6. Demonstrate effective communication and teamwork during resuscitation of a critically ill patient.

Linked objectives, methods and results:

Cocaine toxicity causing cardiopulmonary failure is a condition that requires rapid mobilization and resuscitation, but is not frequently encountered in the clinical setting. As such, it is a valuable simulation for learners to be exposed to this otherwise rare scenario. While working through the case, learners will demonstrate each of the above objectives. By practicing this case through a simulation, learners can respond to a high-stress situation in a safe environment. The simulation can be repeated and practiced at the learners' own pace if needed. This

simulation reinforces important though rarely used skills and therapeutics with an opportunity for feedback and debriefing upon completion, which further solidifies the learning objectives.

Recommended pre-reading for instructor:

- Thomas JJ, Brady WJ. Acute coronary syndrome. In: Walls RM, Hockberger RS, Gausche-Hill M, eds. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 9th ed. Philadelphia, PA: Elsevier; 2018:891-928.

Results and tips for successful implementation:

This simulation is best implemented using a high-fidelity mannequin. This simulation was tested on a total of 15 learners in groups of 4 or 5 during the month of October in 2017. The simulation was positively received by the learners. As a result of the implementation, it was noted that some participants failed to identify the pulmonary edema and did not start a nitroglycerin drip. In cases where the participants failed to identify key components to the management of the patient, the nursing staff was prompted to verbally ask the team leader if they want to take a closer look at a laboratory finding or imaging study. There were no other issues with the implementation of the simulation and no major changes were made after the pilot group.

References/suggestions for further reading:

1. Substance Abuse and Mental Health Services Administration. Results from the 2009 National Survey on Drug Use and Health: Volume I. Summary of National Findings. NSDUH Series H-38A, HHS Publication No. SMA 10-4586. Rockville, MD: Office of Applied Studies, Substance Abuse and Mental Health Services Administration; 2010.
2. Substance Abuse and Mental Health Services Administration. Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings. NSDUH Series H-48, HHS Publication No. (SMA) 14-4863. Rockville, MD: Substance Abuse and Mental Health Services Administration; 2014.
3. Thomas JJ, Brady WJ. Acute coronary syndrome. In: Walls RM, Hockberger RS, Gausche-Hill M, eds. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 9th ed. Philadelphia, PA: Elsevier; 2018:891-928.



INSTRUCTOR MATERIALS

Case Title: Cocaine-Induced Myocardial Infarction and Pulmonary Edema

Case Description & Diagnosis (short synopsis): Mr. James is a 65-year-old Caucasian, homeless male brought in by emergency medical services (EMS). He presents with chest pain after smoking cocaine. The patient develops a STEMI with flash pulmonary edema. Learners must diagnose, manage, and treat the cardiopulmonary failure. If the learners do not properly manage the case, the patient will undergo cardiac arrest and die.

Equipment or Props Needed:

High-fidelity adult male simulation mannequin

Dirty and worn out clothes to place onto mannequin

"Crack pipe" or sugar in Ziploc bag in shirt pocket of mannequin

Cardiac monitor and pulse oximetry

Intravenous (IV) pole and lines

Oxygen, nasal cannula, non-rebreather face mask, bag-valve mask, Bilevel positive airway pressure (BiPAP) face mask

Crash cart

Intubation materials including Mac or Miller blades, stylet, endotracheal tube, suction, 10cc syringe

Normal saline bags (1L, 500mL, 250mL)

Foley catheter

Bedside fan, water, bed sheets (this allows more realism for learners, if not available, can just let learners order them and inform them they are being brought in).

Medications: Naloxone, lorazepam, midazolam, Toradol, acetaminophen, nitroglycerin drip, ketamine, propofol, etomidate, rocuronium, vecuronium, succinylcholine, aspirin, clopidogrel, heparin drip

Confederates needed:

Paramedic

Primary Nurse

Stimulus Inventory:

#1 Electrocardiogram (ECG)

#2 Chest X-ray

#3 Head Computed tomography (CT)

#4 Complete blood count (CBC)



INSTRUCTOR MATERIALS

- #5 Comprehensive metabolic panel (CMP)
- #6 Pre-intubation arterial blood gas (ABG)
- #7 Post-intubation ABG
- #8 Coagulation studies
- #9 Troponin
- #10 Creatine kinase (CK)
- #11 Thyroid-stimulating hormone (TSH)/free T4
- #12 Ammonia
- #13 Urinalysis
- #14 Urine drug screen
- #15 Acetaminophen level
- #16 Salicylate level
- #17 Alcohol level
- #16 Fingerstick glucose

Background and brief information: Mr. James is a 65-year-old Caucasian male brought in by EMS to a community emergency department from a homeless shelter. Chief complaint is chest pain. Patient is confused and unable to provide history.

Initial presentation: On arrival, the patient is agitated and clutching his chest. He is diaphoretic, tachypneic, and is having rigors. If asked questions, the patient only grunts and mumbles incomprehensible words. Paramedics were unable to obtain collateral history. Initial pulse oximetry was 87% on RA (room air), and he was placed on 2L of oxygen via nasal cannula. His glucose was 101. EMS was unable to start an intravenous (IV) line. They gave 2mg of naloxone intranasally without response.

How the scenario unfolds: Paramedics provide a brief description to the participants about the patient. The participants should make sure the patient has adequate vascular access, oxygen, and place the patient on a monitor. The participants should complete a primary and secondary survey and order labs and imaging. They should recognize the vital signs as consistent cocaine toxicity and hopefully find the drug paraphernalia during exam. Once recognized, the patient should be treated with benzodiazepines as the first-line agent. Treatment with benzodiazepines will improve the patient's agitation, heart rate, and blood pressure.



INSTRUCTOR MATERIALS

During the course of the simulation, the patient's respiratory status deteriorates due to pulmonary edema, and he will require intubation. If the learners do not intubate during respiratory failure, have the nurse draw attention to the saturations and patient's Glasgow Coma Scale (GCS). If they still do not intubate the patient, instructor can have the patient code. After intubation the patient will continue to have hypertension and hypoxia; provide the pre-intubation chest X-ray, and learners should recognize the pulmonary edema and order a nitroglycerin drip. If nitroglycerin drip is not ordered, instructor can have the patient code.

Upon return of lab and imaging results, the learners should diagnose and manage the STEMI. If they did not previously recognize the likely cocaine toxicity, then the urine drug screen should point them in this direction. If participants still do not treat the cocaine toxicity, the instructor can have the patient code. Finally, the participants should emergently consult cardiology and send the patient to the cardiac catheterization lab, and then the intensive care unit.

Alternatively, for more junior learners, instead of having the patient code the instructor can have the nurse or cardiologist (if consulted for the STEMI) prompt the learner depending on which critical action has been missed:

- Did not treat the hyperthermia: “What do you think is causing his elevated temperature?”
- Did not treat the pulmonary edema: “What do you think is causing his continued hypoxia?”
- Did not treat the cocaine toxicity: “I don’t think he is stable for cardiac catheterization with those vitals. Is there anything else you can do to stabilize him?”

Critical Actions:

1. Obtain adequate vascular access, supplement oxygen as needed, and place the patient on the monitor.
2. Complete a primary and secondary survey.
3. Order labs, ECG, chest X-ray, CT Head, and toxicology labs.
4. Recognize respiratory failure and intubate the patient.
5. Recognize hyperthermia and treat with benzodiazepines and/or cooling measures.
6. Identify pulmonary edema and treat with nitroglycerin drip.
7. Identify the STEMI and activate the cardiac catheterization lab.
8. Treat cocaine toxicity with benzodiazepines.
9. Transfer the patient to the cardiac catheterization lab.



INSTRUCTOR MATERIALS

Case Title: Cocaine-Induced Myocardial Infarction and Pulmonary Edema

Chief Complaint: Chest Pain

Vitals: Heart Rate (HR) 130 Blood Pressure (BP) 220/150 Respiratory Rate (RR) 27
Temperature (T) 40°C Oxygen Saturation (O₂Sat) 90% on 2L nasal canula (NC)

General Appearance: Lethargic, agitated, incomprehensible mumbling and yelling intermittently, moderate distress, disheveled.

Primary Survey:

- **Airway:** Intact.
- **Breathing:** Bilateral breath sounds with rales, tachypneic, intercostal and subcostal retractions.
- **Circulation:** Tachycardic, bilateral radial and dorsalis pedis pulses intact.

History:

- **History of present illness:** Mr. Rick James is a 65-year-old Caucasian male brought in by EMS. Bystanders at the homeless shelter witnessed him walking around the building and talking to himself. Patient then reportedly sat in a corner and inhaled a substance from a pipe. Subsequently he became agitated and started clutching his chest. He is diaphoretic, tachypneic, and is having rigors.

Paramedics were unable to obtain vascular access; initial pulse oximetry was 87% on room air. He was placed on 2L of oxygen via nasal canula. Fingertstick glucose by paramedics was 101. He was given 2mg naloxone intranasally without response.

- **Past medical history:** Unknown
- **Past surgical history:** Unknown
- **Patient's medications:** Unknown
- **Allergies:** Unknown
- **Social history:** Unknown
- **Family history:** Unknown
- **Weight:** 74 kg



INSTRUCTOR MATERIALS

Secondary Survey/Physical Examination:

- **General appearance:** Disheveled male who appears stated age in moderate distress. He is agitated, intermittently mumbling and yelling incoherently.
- **HEENT:**
 - **Head:** within normal limits
 - **Eyes:** pupils 8 mm equal bilateral and reactive
 - **Ears:** within normal limits
 - **Nose:** within normal limits
 - **Throat:** within normal limits
- **Neck:** within normal limits
- **Heart:** Tachycardic, S1 and S2, no murmurs, rubs, or gallops. No carotid bruit, strong peripheral pulses. No signs of jugular venous distension or lower extremity edema.
- **Lungs:** Tachypneic, bilateral rales with intercostal and subcostal retractions. No chest wall tenderness.
- **Abdominal/GI:** Soft, non-tender, non-distended, no guarding or rebound, decreased bowel sounds.
- **Genitourinary:** within normal limits
- **Rectal:** within normal limits
- **Extremities:** within normal limits
- **Back:** within normal limits
- **Neuro:** Agitated, awake, alert, not oriented. Not following commands, opens eyes to pain, localizes to pain, with confused speech (Glasgow Coma Scale 11). Cranial nerves grossly intact. Reflexes 3+ throughout, no clonus.
- **Skin:** warm, diaphoretic
- **Lymph:** within normal limits
- **Psych:** confused, irritable



INSTRUCTOR MATERIALS

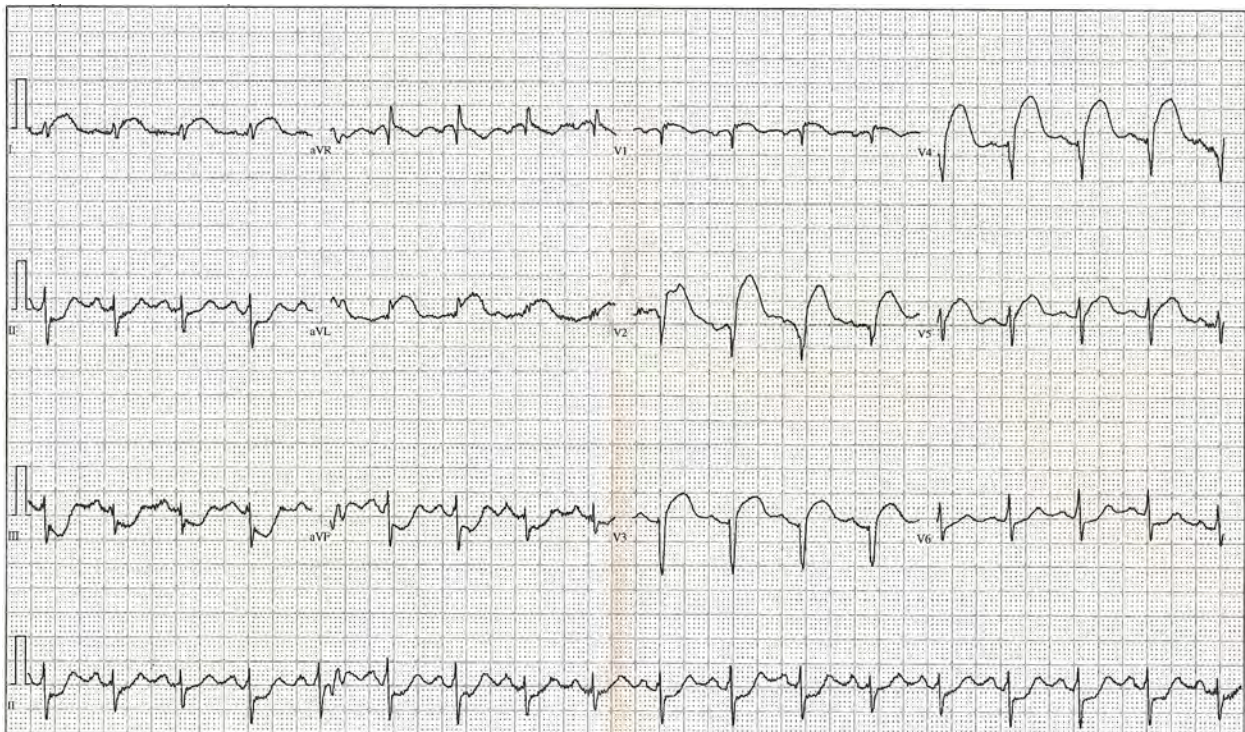
Results:

Electrocardiogram (ECG)

ECG of Anterior STEMI

Displaced. 12 Lead ECG EKG showing ST Elevation (STEMI), Tachycardia, Anterior Fascicular Block, Anterior Infarct, Heart Attack. In: Wikimedia Commons [free media repository].

https://commons.wikimedia.org/wiki/File:12_Lead_EKG_ST_Elevation_tracing_only.jpg. The Wikimedia Foundation; May 20, 2008.





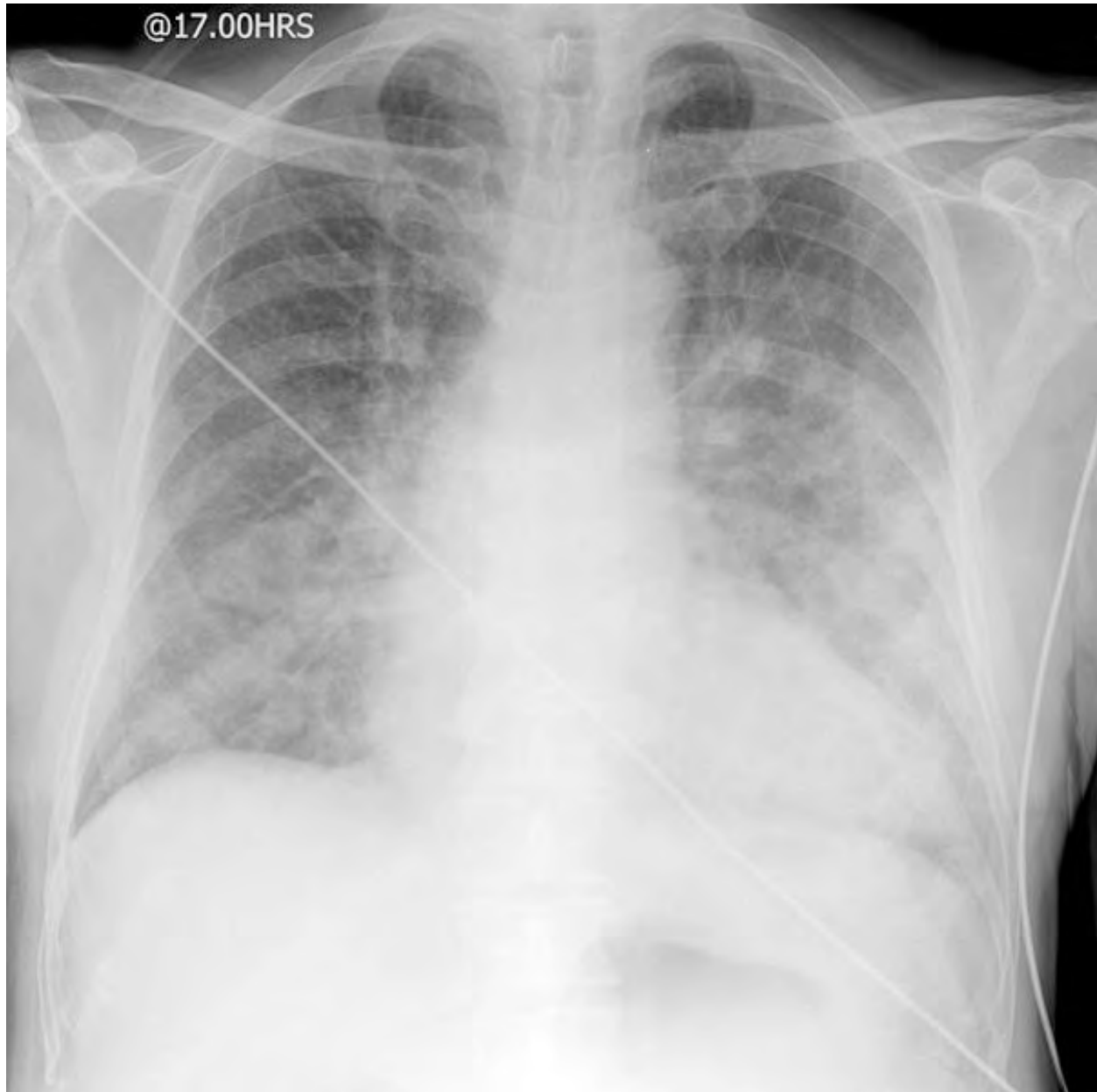
INSTRUCTOR MATERIALS

Chest Radiograph (CXR)

Chest X-ray of Pulmonary Edema

Frank Gaillard, Jeremy Jones. AP portable CXR of a patient in acute pulmonary edema. In: Wikimedia Commons [free media repository].

[https://commons.wikimedia.org/wiki/File:AP_portable CXR of a patient in acute pulmonary oedema.jpg](https://commons.wikimedia.org/wiki/File:AP_portable_CXR_of_a_patient_in_acute_pulmonary_oedema.jpg). The Wikimedia Foundation; July 23, 2009. GF-DL 1.3, CC-BY SA 3.0.





INSTRUCTOR MATERIALS

Head Computed Tomography (CT)

CT Head Unremarkable

Aaron G. Filler. Brain CT Scan. In: Wikipedia [free encyclopedia].

https://en.wikipedia.org/wiki/File:Brain_CT_scan.jpg. The Wikipedia Foundation; July 8, 2009.

GF-DL 1.2, CC-BY SA 3.0.





INSTRUCTOR MATERIALS

Complete blood count (CBC)

White blood count (WBC)	12.5 x1000/mm ³ (H)
Hemoglobin (Hgb)	13.5 g/dL
Hematocrit (HCT)	40%
Platelet (Plt)	160 x1000/mm ³

Comprehensive metabolic panel (CMP)

Sodium	138 mEq/L
Chloride	98 mEq/L
Potassium	5.0 mEq/L
Bicarbonate (HCO ₃)	15 mEq/L
Blood Urea Nitrogen (BUN)	12 mg/dL
Creatine (Cr)	2.0 mg/dL
Glucose	110 mg/dL
Calcium	10.0 mg/dL
Aspartate Aminotransferase (AST)	33 u/L
Alanine Aminotransferase (ALT)	29 u/L
Total Bilirubin (T bili)	0.8 mg/dL
Alkaline Phosphate (alk phos)	46 u/L

Pre-intubation arterial blood gas (ABG)

pH	7.50
pCO ₂	26 mm Hg
pO ₂	59 mm Hg
Bicarbonate (HCO ₃)	20 mEq/L

Post-intubation arterial blood gas (ABG)

pH	7.40
pCO ₂	35 mm Hg
pO ₂	75 mm Hg
Bicarbonate (HCO ₃)	22 mEq/L

Coagulation Studies

Prothombin Time (PT)	18 seconds
International Normalized Ratio (INR)	1.5
Partial Thromboplastin Time (PTT)	62 seconds



INSTRUCTOR MATERIALS

Troponin

Troponin-I 2.5 ng/mL (normal <0.04 ng/mL)

Creatine kinase (CK)

CK 500 units/L

Thyroid Panel

Thyroid-stimulating hormone 3 mIU/L

Free T4 1 ng/dL

Ammonia

Ammonia 20 μ /dL

Urinalysis

Color	yellow
Clarity	clear
Protein	negative
Glucose	negative
Ketones	negative
Bilirubin	negative
Hemoglobin	negative
Leukocyte esterase	negative
Nitrite	negative
Red blood cells (RBC)	< 0 /HPF
White blood cells (WBC)	0 /HPF
Bacteria	none
Squamous epithelial	< 0 /HPF
Mucous	0 /LPF



INSTRUCTOR MATERIALS

Urine Toxicology Screen

Opiates	negative
Cocaine	positive
Marijuana	negative
PCP	negative
Amphetamines	negative
Benzodiazepines	negative
Barbiturates	negative
Methadone	negative
Propoxyphene	negative
MDMA	negative

Acetaminophen level

Acetaminophen level 0 mcg/mL

Salicylate level

Salicylate level 0 mcg/mL

Alcohol level

Alcohol level 0 mcg/mL

Fingerstick glucose

Glucose 101 mg/dL



OPERATOR MATERIALS

SIMULATION EVENTS TABLE:

Minute (State)	Participant action/ Trigger	Patient Status (Simulator response) & Operator Prompts	Monitor Display (Vital Signs)
0:00 (Baseline)	<p>IV lines placed, provide supplemental oxygen, place on monitor.</p> <p>Complete primary survey airway, breathing, circulation.</p>	<p>Patient in bed, lethargic, GCS 11 (opens eyes to pain, localizes to pain, confused speech), pain 8/10, tachypneic.</p> <p>Airway is intact, there are breath sounds bilateral, patient is hypertensive, tachycardic, and hyperthermic.</p> <p>EMS unable to give further history. No collateral information.</p>	<p>T: 40C HR: 130 BP: 220/150 RR: 27 O₂sat: 90% on 2L NC</p>
2:00	<p>Complete secondary survey.</p> <p>Discover crack pipe or cocaine in Ziploc.</p> <p>Order labs, ECG, CXR, CT head.</p>	<p>Crack pipe or “cocaine” in Ziploc bag should be on mannequin or operator can verbally state these are found when participants ask for physical exam.</p> <p>If learner asks for nitroglycerin drip, it is delayed and coming from pharmacy.</p>	<p>T: 40°C HR: 130 BP: 220/150 RR: 27 O₂sat: 90% on 2L NC</p>
4:00 4:00 (continued)	<p>Recognize impending respiratory failure and worsening mental status.</p> <p>RSI and intubate</p>	<p>Patient becomes more obtunded, GCS 7 (open eyes to pain, no verbal, withdraws to pain), with significant retractions.</p> <p>If learner asks for nitroglycerin drip, it is delayed and coming from pharmacy.</p> <p>If asks for BiPAP, say it is applied with no improvement in status.</p> <p>If respiratory failure is not addressed, have the patient arrest (see code below)</p>	<p>Before intubation: T: 40°C HR: 135 BP: 225/160 RR: 30 O₂sat: 80%</p> <p>After intubation: T: 40°C HR: 135 BP: 225/160 RR: 12 O₂sat: 90% intubated</p> <p>If patient not intubated: Have the patient code (see code below)</p>



OPERATOR MATERIALS

Minute (State)	Participant action/ Trigger	Patient Status (Simulator response) & Operator Prompts	Monitor Display (Vital Signs)
6:00	Recognize hyperthermia and treat with benzodiazepines (benzos) or external cooling measures (for example a wet blanket, ice packs or bed fans)	<p>If benzos and/or cooling measures are ordered, the vitals will improve to temperature 38°C and HR 100.</p> <p>If learner does not recognize and treat the hyperthermia, instructor can prompt them with “what do you think is causing his elevated temperature?”</p>	<p>If benzos and/or cooling measures ordered: T: 38°C HR: 100 BP: 140/90 RR: 12 O₂sat: 100% intubated</p> <p>If benzos and/or cooling measures not ordered: T: 40°C HR: 130 BP: 140/90 RR: 12 O₂sat: 100% intubated</p>
	Recognize flash pulmonary edema and order nitroglycerin drip	<p>If nitroglycerin drip was ordered at any point previously or now, nurse can start it. Blood pressure will decrease to 140/90.</p> <p>If nitroglycerin drip not ordered have oxygen saturation continue to decrease and patient code (see code below). Alternatively, for more junior learners the instructor can have the nurse prompt participants with “what do you think is causing his continued hypoxia?”</p>	<p>If benzos and/or cooling measures AND nitroglycerin drip ordered: T: 38°C HR: 100 BP: 140/90 RR: 12 O₂sat: 100% intubated</p> <p>If benzos and/or cooling measures NOT ordered but nitroglycerin drip ordered: T: 40°C</p>



OPERATOR MATERIALS

Minute (State)	Participant action/ Trigger	Patient Status (Simulator response) & Operator Prompts	Monitor Display (Vital Signs)
8:00			<p>HR: 130 BP: 150/95 RR: 12 O₂sat: 100% intubated</p> <p>If nitroglycerin drip NOT ordered: Decrease O₂sat and have patient code (see code below)</p>
9:00	<p>Interpret labs and imaging</p> <p>Recognize and treat STEMI: aspirin, antiplatelet, heparin drip, activate cardiac catheterization lab.</p>	<p>GCS 3T.</p> <p>EKG and troponin suggestive of STEMI are available.</p> <p>Other labs, CXR, CT Head are available.</p> <p>If STEMI is not recognized and cardiac catheterization lab not activated, have patient arrest (see code below).</p> <p>Cardiology will not be immediately available for call back; learners should be prompted to continue managing the patient until they call back.</p>	<p>If benzos and/or cooling measures AND nitroglycerin drip ordered: T: 38°C HR: 100 BP: 140/90 RR: 12 O₂sat: 100% intubated</p> <p>If benzos and/or cooling measures NOT ordered but nitroglycerin drip ordered: T: 40°C HR: 130 BP: 150/95</p>



OPERATOR MATERIALS

Minute (State)	Participant action/ Trigger	Patient Status (Simulator response) & Operator Prompts	Monitor Display (Vital Signs)
			RR: 12 O ₂ sat: 100% intubated If STEMI not recognized and treated: Have the patient code (see code below)
10:00	Recognize that cocaine toxicity is the likely etiology of the patient's symptoms and treat with benzodiazepines.	GCS 3T. If benzodiazepines are not ordered have the patient arrest (see code below) Alternatively, for more junior learners the instructor can have the cardiologist call back and prompt participants with "I don't think he is stable for cardiac catheterization with those vitals. Is there anything else you can do to stabilize him?"	If benzos ordered: T: 38°C HR: 95 BP: 130/80 RR: 12 O ₂ sat: 100% intubated If benzos not ordered: Have patient code (see code below)
15:00 (Case Completion)	Discussion with cardiology and transfer patient to cardiac catheterization lab	GCS 3T. Cardiology will call back and accept the patient for cardiac catheterization.	T: 38°C HR: 95 BP: 130/80 RR: 12 O ₂ sat: 100% intubated
(Code)	Advanced Cardiac Life Support (ACLS)	If critical actions (nitroglycerin drip, benzodiazepines, or cardiac catheterization activation) are not completed, have the patient code (rhythm will start as ventricular fibrillation). If participants do not follow ACLS (adequate chest compressions, epinephrine) degrade to asystole without return of spontaneous circulation (ROSC).	T :40°C HR: ventricular fibrillation on monitor BP: -- RR: 0 O ₂ sat: --



OPERATOR MATERIALS

Minute (State)	Participant action/ Trigger	Patient Status (Simulator response) & Operator Prompts	Monitor Display (Vital Signs)
		If participants follow ACLS (adequate chest compressions, epinephrine): Return mannequin to the previous state and vitals. Instructor may choose to prompt learners for missing critical action as discussed above.	
(Second Code)	Advanced Cardiac Life Support (ACLS)	If patient codes a second time due to continued missing critical actions (nitroglycerin drip, benzodiazepines, cardiac catheterization activation): Rhythm starts as ventricular fibrillation and degrades to asystole without ROSC regardless of participant actions.	T: 40°C HR: ventricular fibrillation on monitor BP: -- RR: 0 O ₂ sat: --

Diagnosis:

Cocaine-induced STEMI and flash pulmonary edema

Disposition:

Cardiac catheterization lab, and then admission to the ICU (intensive care unit)



DEBRIEFING AND EVALUATION PEARLS

Cocaine Induced STEMI and Flash Pulmonary Edema

- Cocaine causes sympathomimetic toxidrome
 - Primary mechanism is blocking reuptake of norepinephrine in sympathetic neurons as well as increasing central sympathetic outflow
 - Elevation in heart rate, blood pressure, respiratory rate, and temperature
 - Mydriasis, diaphoresis, agitation
 - Mainstay of treatment is benzodiazepines and supportive care
 - Diazepam 5-10mg IV, repeat every 5-10 minutes until sedated
 - Lorazepam 1-2mg IV, repeat every 5-10 minutes until sedated
- Cardiovascular Complications of Cocaine
 - Alpha adrenergic stimulation and endothelial dysfunction (release of endothelin causing more vasoconstriction and inhibiting nitric oxide production) in even low doses; sodium channel blockade akin to class I antiarrhythmic agent at higher doses.
 - Coronary artery vasoconstriction combined with increased myocardial oxygen demand from increased HR and BP put patients (even young patients without history of coronary artery disease) at risk for acute myocardial infarction, congestive heart failure, and ventricular arrhythmia.
 - ECG may show signs of ischemia (ST segment changes, T wave inversions); at very high levels of ingestion may show QRS widening from sodium channel blockade.
 - Acute coronary syndrome (ACS) should be treated according to standard protocol including aspirin, nitroglycerin, heparin, antiplatelet agents, and coronary angiography with percutaneous coronary intervention with the exception of avoidance of selective beta blockers.
 - QRS widening typically signifies profound toxicity and should be treated with sodium bicarbonate 1-2 MEq IV bolus.
 - Hypertension not improving with benzodiazepine therapy
 - Add phentolamine (alpha 1 adrenergic inhibitor) 5mg IV q 2-4 hours; helps with coronary vasoconstriction as well but may cause reflex tachycardia.
 - Consider using nitroglycerin 0.4mg sublingual x3 or starting nitroglycerin drip.
 - Beta blockers, especially selective beta blockers metoprolol and esmolol are not recommended over concerns that they may worsen the hypertension due to theoretical risk of unopposed alpha-adrenergic stimulation.^{6,7}
 - This is theoretical and based on case series and small studies.
 - Labetalol and carvedilol are nonselective and studies are mixed. They have been shown to decrease sympathetic outflow and improve HR and



DEBRIEFING AND EVALUATION PEARLS

BP but have not been shown to decrease coronary vasoconstriction.

Many authors still recommend against their use.

- Pulmonary edema can occur rapidly and can be cardiogenic pulmonary edema from cardiac complications and ACS, or can be noncardiogenic pulmonary edema from alveolar damage and hemorrhage (from smoking cocaine, known as “crack lung”).
 - Treatment with noninvasive positive pressure ventilation (NIPPV) and nitrates.
 - If too altered for NIPPV or not improving, endotracheal intubation and ventilation may be necessary.
 - Etomidate and rocuronium are recommended induction agents.
 - Avoid succinylcholine because this may prolong the effects of cocaine.
- Management of non-exertional hyperthermia
 - Delayed recognition of hyperthermia increases likelihood of death. May lead to elevated CK and rhabdomyolysis.
 - Rapid cooling to 38.3°C within 30 minutes is the goal.
 - Ice baths are very effective for rapid and efficient cooling but are more dangerous for elderly patients², are difficult to accomplish for agitated patients, and make close monitoring much more challenging.
 - Convective and evaporative cooling is the mainstay of active external cooling and is efficient, logistically simple, and does not interfere with other aspects of patient care.
 - For cocaine toxicity, cooling should be combined with treating the adrenergic overload with benzodiazepines (diazepam 5-10mg IV q5-10 minutes), phentolamine (for refractory HTN despite benzodiazepines, 5mg IV q2-4 hours).
 - Treating the cocaine toxicity concomitantly is essential as it causes impaired heat dissipation from sweating and cutaneous vasodilation.¹
- Differential Diagnosis for Toxin-Mediated Hyperthermia
 - Anticholinergic Toxidrome
 - Shared symptoms of elevated HR, BP, temp, mydriasis and altered mental state.
 - Skin will be warm, red, and dry as opposed to diaphoretic in cocaine toxicity.
 - Serotonin syndrome
 - Shared symptoms of elevated HR, BP, temperature, mydriasis, diaphoresis.
 - Look for clonus and increased tone in lower limbs > upper limbs.⁸
 - Neuroleptic Malignant Syndrome
 - Shared symptoms of elevations in HR, BP, temperature, RR.
 - Pupils normal or mydriasis, skin diaphoretic but may be pale.



DEBRIEFING AND EVALUATION PEARLS

- Look for “lead pipe” rigidity and bradyreflexia.

Other debriefing points:

Start by discussing what the team did well and about how they think the simulation went. If learners did not have paramedics stay in the room, ask learners "In patients who cannot provide a history, what are ways that providers can obtain more information?"

If learners missed the diagnosis of cocaine intoxication, STEMI, or flash pulmonary edema, start by asking “what do you think was going on with the patient?” By discussing laboratory results, imaging, and vitals, learners may be guided to arrive at these diagnoses.

If learners fail to start appropriate therapies, ask what they think would be the treatments for these diagnoses.

Was closed-loop communication used in this case? How was the teamwork among learners? If the disposition for the patient was not to cardiology, ask about the thought process for their disposition.

References:

1. Crandall CG, Vongpatanasin W, Victor RG. Mechanism of cocaine-induced hyperthermia in humans. *Ann Intern Med.* 2002;136(11):785-791. doi: 10.7326/0003-4819-136-11-200206040-00006
2. Gaudio FG, Grissom CK. Cooling methods in heat stroke. *J Emerg Med.* 2016;50(4):607-616. doi: 10.1016/j.jemermed.2015.09.014
3. Lange RA, Hillis LD. Cardiovascular complications of cocaine use. *N Engl J Med.* 2001;345(5):351-358. doi: 10.1056/NEJM200108023450507
4. Nixon C. Hyperthermia-associated toxidromes. Life in the Fastlane. <https://lifeinthefastlane.com/cc/hyperthermia-associated-toxidromes/>. Published November 7, 2017. Accessed September 27, 2018.
5. Richards JR, Garber D, Laurin EG, et al. Treatment of cocaine cardiovascular toxicity: a systematic review. *Clin Toxicol (Phila).* 2016;54(5):345-364. doi: 10.3109/15563650.2016.1142090
6. Richards JR, Hollander JE, Ramoska EA, et al. β -Blockers, cocaine, and the unopposed α -stimulation phenomenon. *J Cardiovasc Pharmacol Ther.* 2017;22(3):239-249. doi: 10.1177/1074248416681644
7. Schwartz BG, Rezkalla S, Kloner RA. Cardiovascular effects of cocaine. *Circulation.* 2010;122(24):2558-2569. doi: 10.1161/circulationaha.110.940569



DEBRIEFING AND EVALUATION PEARLS

8. Swaminathan A. Hyperthermia Syndromes. R.E.B.E.L. EM. <http://rebelem.com/hyperthermia-syndromes/>. Published October 17, 2016. Accessed September 27, 2018.



SIMULATION ASSESSMENT

Cocaine-induced Myocardial Infarction and Pulmonary Edema

Learner: _____

Assessment Timeline

This timeline is to help observers assess their learners. It allows observer to make notes on when learners performed various tasks, which can help guide debriefing discussion.

Critical Actions

1. Obtain adequate vascular access, supplement oxygen as needed, and place the patient on the monitor.
2. Complete a primary and secondary survey.
3. Order labs, ECG, chest X-ray, CT Head, and toxicology labs.
4. Recognize respiratory failure and Intubate the patient.
5. Recognize hyperthermia and treat with benzodiazepines and/or cooling measures.
6. Identify pulmonary edema and treat with nitroglycerin drip.
7. Identify the STEMI and activate the cardiac catheterization lab.
8. Treat cocaine toxicity with benzodiazepines.
9. 9. Transfer the patient to the cardiac catheterization lab.

0:00



SIMULATION ASSESSMENT

Cocaine-induced Myocardial Infarction and Pulmonary Edema

Learner: _____

Critical Actions:

- Obtain adequate vascular access, supplement oxygen as needed, and place the patient on the monitor.
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- Treat cocaine toxicity with benzodiazepines.
- Transfer the patient to the cardiac catheterization lab.

Summative and formative comments:

Milestones assessment:

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
1	Emergency Stabilization (PC1)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Recognizes abnormal vital signs	<input type="checkbox"/> Recognizes an unstable patient, requiring intervention Performs primary assessment Discerns data to formulate a diagnostic impression/plan	<input type="checkbox"/> Manages and prioritizes critical actions in a critically ill patient Reassesses after implementing a stabilizing intervention



SIMULATION ASSESSMENT

Cocaine-induced Myocardial Infarction and Pulmonary Edema

Learner: _____

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
2	Performance of focused history and physical (PC2)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Performs a reliable, comprehensive history and physical exam	<input type="checkbox"/> Performs and communicates a focused history and physical exam based on chief complaint and urgent issues	<input type="checkbox"/> Prioritizes essential components of history and physical exam given dynamic circumstances
3	Diagnostic studies (PC3)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Determines the necessity of diagnostic studies	<input type="checkbox"/> Orders appropriate diagnostic studies. Performs appropriate bedside diagnostic studies/procedures	<input type="checkbox"/> Prioritizes essential testing Interprets results of diagnostic studies Reviews risks, benefits, contraindications, and alternatives to a diagnostic study or procedure
4	Diagnosis (PC4)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Considers a list of potential diagnoses	<input type="checkbox"/> Considers an appropriate list of potential diagnosis May or may not make correct diagnosis	<input type="checkbox"/> Makes the appropriate diagnosis Considers other potential diagnoses, avoiding premature closure
5	Pharmacotherapy (PC5)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Asks patient for drug allergies	<input type="checkbox"/> Selects an medication for therapeutic intervention, consider potential adverse effects	<input type="checkbox"/> Selects the most appropriate medication and understands mechanism of action, effect, and potential side effects Considers and recognizes drug-drug interactions



SIMULATION ASSESSMENT

Cocaine-induced Myocardial Infarction and Pulmonary Edema

Learner: _____

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
6	Observation and reassessment (PC6)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Reevaluates patient at least one time during case	<input type="checkbox"/> Reevaluates patient after most therapeutic interventions	<input type="checkbox"/> Consistently evaluates the effectiveness of therapies at appropriate intervals
7	Disposition (PC7)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Appropriately selects whether to admit or discharge the patient	<input type="checkbox"/> Appropriately selects whether to admit or discharge Involves the expertise of some of the appropriate specialists	<input type="checkbox"/> Educates the patient appropriately about their disposition Assigns patient to an appropriate level of care (ICU/Tele/Floor) Involves expertise of all appropriate specialists
9	General Approach to Procedures (PC9)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Identifies pertinent anatomy and physiology for a procedure Uses appropriate Universal Precautions	<input type="checkbox"/> Obtains informed consent Knows indications, contraindications, anatomic landmarks, equipment, anesthetic and procedural technique, and potential complications for common ED procedures	<input type="checkbox"/> Determines a back-up strategy if initial attempts are unsuccessful Correctly interprets results of diagnostic procedure
20	Professional Values (PROF1)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Demonstrates caring, honest behavior	<input type="checkbox"/> Exhibits compassion, respect, sensitivity and responsiveness	<input type="checkbox"/> Develops alternative care plans when patients' personal beliefs and decisions preclude standard care



SIMULATION ASSESSMENT

Cocaine-induced Myocardial Infarction and Pulmonary Edema

Learner: _____

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
22	Patient centered communication (ICS1)	<input type="checkbox"/> Did not achieve level 1	<input type="checkbox"/> Establishes rapport and demonstrates empathy to patient (and family) Listens effectively	<input type="checkbox"/> Elicits patient's reason for seeking health care	<input type="checkbox"/> Manages patient expectations in a manner that minimizes potential for stress, conflict, and misunderstanding. Effectively communicates with vulnerable populations, (at risk patients and families)
23	Team management (ICS2)	<input type="checkbox"/> Did not achieve level 1	<input type="checkbox"/> Recognizes other members of the patient care team during case (nurse, techs)	<input type="checkbox"/> Communicates pertinent information to other healthcare colleagues	<input type="checkbox"/> Communicates a clear, succinct, and appropriate handoff with specialists and other colleagues Communicates effectively with ancillary staff