THE G. S. BECKWITH GILBERT AND KATHARINE S. GILBERT MEDICAL EDUCATION

PROGRAM IN MEDICAL SIMULATION

HARVARD MEDICAL SCHOOL

SIMULATION CASEBOOK

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RESPIRATORY

TRAUMA

NOTE FROM THE EDITORS

This casebook comprises a collection of selected simulation cases developed, refined, and deployed in the teaching laboratories of the Gilbert Program in Medical Simulation at Harvard Medical School. They have been drafted, edited, and adapted by several classes of teaching fellows and core faculty who comprise the Gilbert Simulation Team. Collectively, these cases have been used to teach thousands of students.

We have edited and enhanced these cases to ensure medical accuracy and uniformity (N.B. the standardized case template used throughout was adapted from the Simulation Case Template developed by the Society for Academic Emergency Medicine Simulation Interest Group). As written, the cases are intended for a broad array of learners, ranging from preclinical medical students and doctoral graduate students to interns and advanced residents. There are optional case progressions, with case variations and suggestions to prompt the learner or guide the case. For advanced learners, a more challenging scenario can be adapted by utilizing the points in italics. Of note, basic variants of several of these cases have been used to teach sophisticated biomedical concepts to high school and college students as part of the Harvard Summer PreMedical Institute and Harvard Medical School Bioscience Program for High School Students.

To enhance the simulation experience, multimedia links are provided to EKG, radiography, and other resources on the internet.

We hope that a consolidated, central source of successfully tested and deployed simulation cases will be a valuable addition to many medical teaching programs, and will help stimulate further development of standardized approaches to simulation-based teaching and assessment.

We are grateful for the support of G.S. Beckwith Gilbert and the Gilbert Family Foundation. Special thanks to the Simulation Fellows, Staff, and Faculty who made this work possible.

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CARDIOVASCULAR CASES

Gilbert Program in Medical Simulation

Harvard Medical School

Anterior Myocardial Infarction

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter.

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Immediate ECG and portable CXR (within 10 minutes of start of case)
☐	Obtain appropriate laboratory studies: cardiac biomarkers
☐	Administer immediate aspirin
☐	*Administer pressor agent*
☐	Administer anticoagulation medication
☐	Consult cardiology for further treatment

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG, recommends treatment plan

Case Narrative

PATIENT: 60 year old
CC: Chest pain, "There is an elephant sitting on my chest."

HPI: *Use lay terminology as the voice of the patient*
Patient complains of crushing substernal chest pain radiating to his neck and jaw on the left side. Symptoms started one hour ago during a business meeting. Patient had to excuse himself from the meeting as he became obviously diaphoretic and pale.

Patient reports nausea and lightheadedness after the onset of the "crushing" chest pain. Patient denies fevers, chills, vomiting, and palpitations. Patient reports mild shortness of breath and one previous episode of chest pain that lasted about 15 minutes one week ago that resolved spontaneously while he was in Japan.

PMHx:
Hypertension

MEDICATIONS	ALLERGIES
Lisinopril	Codeine Shellfish

PSHx:
Hernia repair, age 22

SOCIAL Hx:
EtOH: Occasional
Tobacco: Denies
Illicits: Denies
Occupation: Ambassador to the U.S.
Additional: Married

FAMILY Hx:
Father: Gastric cancer, expired age 80

ROS:
(+) Chest pain with radiation to neck/jaw, mild shortness of breath, diaphoresis, nausea, lightheadedness

(-) Denies palpitations, vomiting, headache, blurred vision, numbness/motor weakness, abdominal pain, urinary symptoms, or fever/chills

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
110	88/60	37.5^o	92%	24

GENERAL: A&OX3, moderate distress
HEENT: PERRL/EOMI
NECK: Supple, no JVD
CV: 2/6 systolic apical murmur, tachycardia
PULM: Diffuse rales all lung fields
ABD: Soft, NT/ND, + BS
EXT: No C/C/E, palpable pulses all extremities
NEURO: WNL, MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiology – Dr. Jones: ECG will be read as STEMI in leads V1-V6 and leads I and AVL. Cardiology will recommend preparing the patient for cardiac catheterization: aspirin, Plavix, heparin, and "… if it's safe in light of the patient's vital signs," B-blocker and nitroglycerin. Indicate that the catheterization team will need about 20 minutes to get in and that the patient must be stabilized prior to catheterization. Cardiologist asks the students to tell the patient that they will need to have a cardiac catheterization.

If vitals have not been stabilized, tell participants to call back after blood pressure and other vitals improve. If participants ask about increasing the pressure safely, recommend pressors (dopamine).

Radiology – Dr. Smith: CXR shows diffuse pulmonary edema consistent with congestive heart failure.

CLINCAL PROGRESSION:
History and physical, IV/O_2/monitor, and immediate aspirin. *Pressors should be started after physical exam* and stat portable CXR indicative of cardiogenic pulmonary edema with hypotension. ECG will indicate AMI either after participants' own interpretation or after consultation.

*** If over 500 CC's IV fluids given or supplemental O_2 not initiated within the first 10-15 minutes of case, patient will continue providing history in short one word (monosyllabic) answers and indicate that shortness of breath is getting worse. O_2 saturation will drop:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
116	88/60	37.5^o	88%	26

***If Morphine or Nitroglycerin given (sublingual or IV) blood pressure will drop, heart rate will increase but rhythm stays regular, patient will become less responsive:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
122	68/50	37.5^o	92%	24

***If B-blockers given, heart rate and blood pressure will decrease, pt will become unresponsive:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
100	68/50	37.5^o	92%	24

V. Instructor Notes

A. Tips to keep scenario flowing
1. If students are unsure of pathology, instructor can prompt the students to create differential diagnosis and lead them towards imaging and laboratory studies necessary to confirm diagnosis. Prompting can come in form of a primary care physician calling to check in on their patient.
2. If supplemental O_2 is not provided, nurse can verbalize concern as patient becomes increasingly dyspneic

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor
- History and physical examination
- Immediate aspirin
- Appropriate lab workup: CBC, BMP, cardiac markers, coagulation profile
- Appropriate imaging: stat portable CXR, ECG within 10 minutes
- *Administer pressor agent*
- Administer anticoagulation medication (e.g. Heparin, Plavix, +/- IIb/IIIa)
- Consider administering morphine, B-blocker, and nitrates
- Consult cardiology for further treatment

2. Potential complications/errors path(s):
- Failure to administer O_2

- Administering over 500 CC's IV fluid
- Administering large dose of Nitroglycerin, B-blocker, Morphine

VI. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
1. Team dynamics
a. Leadership
b. Collaboration
c. Communication
d. Professionalism
2. Didactic material
a. Presentation
i. Appropriate differential diagnosis
ii. Varying presentation of MI in different location
1. Contrast fluid overload requiring + inotropy from anterior MI with preload dependence and need for IV fluids in inferior MI
b. Pathophysiology
i. Atherosclerotic vs. nonatherosclerotic causes
ii. Laboratory results: troponin, CKMB levels
c. Treatment
i. Need for immediate diagnosis and reperfusion for the acute MI
1. "Time is muscle"
ii. Role of aspirin therapy: decrease mortality/reinfarction rates
iii. Role of other antiplatelet therapy
1. Clopidogrel (Plavix) at 600mg dose if emergent CABG not anticipated
iv. Role of pressors vs. fluids in the anterior MI patient
v. Role of anticoagulants
1. Heparin: indicated in recurrent/persistent chest pain, AMI, positive biomarkers, dynamic EKG changes. Dose is 60U/kg bolus followed by 12U/kg infusion, titrating to apt 1.5-2.5 times control
2. LMWH at 1mg/kg BID, adjusted for renal insufficiency
3. GP IIb/IIIa inhibitor
vi. Role of acute beta-blockade and nitrates
1. B-blocker: heart rate control and resultant decrease of myocardial O_2 demand to reduce rates of reinfarction, recurrent ischemia and potentially mortality
2. Nitrates: preload reduction and symptomatic relief
3. Contraindications in the hypotensive MI patient
a. Hold NTG for SBP < 90
b. Hold BB if signs of cardiogenic shock
vii. Treatment options: thrombolytic therapy vs. heart catheterization (PCI) vs. coronary bypass graft

VII. Development and Deployment

This case, along with it precursors (reference Gordon, below) and variants have been used over several years for a wide range of students, including high school, college, masters/PhD candidates, medical students (preclinical and clinical) and resident trainees. The presentation and progression is tailored to the level of the learner; often the Anterior MI case is paired with the Inferior MI case to allow students to compare and contrast diagnosis, anatomy, physiology, and management. It is commonly used as part of a "train the trainer" curriculum for faculty development in the use of simulation.

VIII. Authors/Contributors

Case drafted by Rami Ahmed, D.O, with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

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X. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	137	135-147 mmol/L
Potassium	3.9	3.5-5.2 mmol/L
Chloride	105	95-107 mmol/L
CO_2	27	22-30 mmol/L
Urea Nitrogen (BUN)	15	7-20 mg/dL
Creatinine	1.1	0.5-1.2 mg/dL
Glucose	103	60-110 mg/dL

CARDIAC MARKERS		Reference Range
Creatine Kinase-BB	0%	0%
Creatine Kinase-MB (cardiac)	2%	0 - 3.9%
Creatine Kinase-MM	98%	96 – 100%
Creatine phosphokinase (CPK)	135	8 – 150 IU/L
Troponin I	0.01	$\leq$ 0.03 ng/mL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	35	30 – 45 sec
Prothrombin time (PT)	12	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 – 2
Fibrinogen	180	170 – 420 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	9,700	4,500 - 10,000 K/uL	
Segmented neutrophils (%)	57	54 – 62%	
Band forms (%)	4	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	15.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	92	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	34	31 – 37 g/dL	
Platelet	420,000	100,000 - 450,000 K/uL	

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Diffuse cardiogenic pulmonary edema bilaterally
http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/diffuse/Dscn017.jpg

ECG:
http://www.rcsed.ac.uk/fellows/bcpaterson/images/chest_12.jpg

XII. Appendix C: Teaching Materials

Angioplasty Video
http://www.youtube.com/watch?v=gcrLzOkACgk&feature=channel

Aortic Stenosis: Angina Followed by Atrial Fibrillation

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter.

Critical Actions Checklist:

DONE	CRITICAL ACTION
	PART I
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	Immediate ECG and CXR
☐	Provide IV fluids
☐	Obtain appropriate laboratory studies: cardiac biomarkers
☐	Admit patient for stress test
	PART II
☐	Obtain additional history
☐	Repeat physical examination and immediate ECG
☐	Electrical or chemical cardioversion
☐	Initiate anticoagulant therapy
☐	*Consider beginning longer acting rate/rhythm control agents after successful cardioversion*

III. Environment

A. Simulation room set up: PART I in emergency department, PART II in either emergency department or on medical floor

B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed

C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)

D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG, recommends treatment plan

V. Case Narrative: Part I

PATIENT: 68 year old
CC: Chest pain, shortness of breath

HPI: *Use lay terminology as the voice of the patient*
Patient presents with chest pain and shortness of breath that began while carrying pipes on a construction site. Patient feels like s/he is suffocating and describes chest pain as a dull pressure that has never been experienced before.

Patient reports that many years ago, a primary care physician said s/he may need some "work" on her/his heart but patient "doesn't know what that means." Patient no longer sees the doctor.

PMHx:
Hypertension
Rheumatic fever, as a child
Prior asbestos exposure, shipyard

MEDICATIONS	ALLERGIES
Atenolol	Aspirin

PSHx: Denies

SOCIAL Hx:
EtOH: Occasional
Tobacco: Denies
Illicits: Denies
Occupation: Plumber
Additional: Married, 2 children

FAMILY Hx:
Mother: Lung cancer, died age 74
Father: Diabetes, still alive

ROS:
(+) Diaphoresis, shortness of breath, chest pain

(-) Nausea, vomiting, fever/chills, constipation/diarrhea, headache, blurred vision, lightheadedness, palpitations, numbness/motor weakness, abdominal pain, or urinary symptoms

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
92	170/100	37.0^o	94%	18

GENERAL: A&Ox3, anxious, diaphoretic
HEENT: Unremarkable
NECK: Supple, no JVD
PULM: Rales scattered (nonspecific)
CV: Systolic ejection murmur and s4 present
ABD: Soft, NT/ND, + BS
EXT: No C/C/E, palpable pulses all extremities
NEURO: MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiology – Dr. Jones: ECG is suggestive of left ventricular hypertrophy (LVH) but there are no other significant findings. Cardiology will recommend admitting the patient for a stress test, echocardiogram to evaluate aortic valve function and potentially cath.

Cardiology consultant will encourage residents to establish diagnosis and management plan themselves, only providing minimal guidance as needed.

CLINICAL PROGRESSION:
History and physical, IV access, supplemental O_2 and monitor. Participants must rule out MI with appropriate laboratory studies and images, administer IV fluids, and determine whether or not to admit

patient. Cardiology consult will recommend admitting patient for further evaluation including stress test with imaging, echo, possible cath.

***If nitroglycerin administered (with or without IV fluids), patient will complain of worsening symptoms and lightheadedness as blood pressure decreases:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
92	120/90	37.0^o	93%	20

***If IV fluids provided, pain and shortness of breath will moderately resolve:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
90	150/100	37.0^o	96%	16

****Debriefing of first case can occur now (guide for debriefing found after PART II of case)

VI. Case Narrative: Part II

***Patient name, past medical history, social and family history as above.

CC: Chest pain, shortness of breath

HPI: *Use lay terminology as the voice of the patient*

Patient (above) was admitted to the inpatient unit and back to baseline vitals, more or less, but is having a second episode of chest pain and dyspnea, this time with lightheadedness. Atrial fibrillation with rapid ventricular response is displayed on the monitor. **ROS:** Initially as above

PHYSICAL EXAM (Atrial Fibrillation): *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
156	80/40	37.0^o	95%	20

GENERAL: A&Ox3, anxious, diaphoretic
HEENT: Unremarkable
NECK: Slighty elevated JVD
PULM: Rales scattered (nonspecific)
CV: Irregularly irregular tachycardia
ABD: Soft, NT/ND, + BS
EXT: No C/C/E, palpable pulses all extremities
NEURO: MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel		Lactate/Cortisol Level	

Cardiac Markers (optional)	X	Thyroid Panel	
Coagulation Profile		Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential		Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiology – Dr. Jones: ECG will indicate atrial fibrillation with rapid ventricular response. Cardiology will recommend immediate cardioversion given the hemodynamic instability of the patient. Depending on the level of the learner, cardiology may give options to the novice learner (chemical cardioversion with beta-blocker, calcium-channel blocker, amiodarone, digoxin, or synchronized electrical cardioversion at 50 joules) *and without specific examples of interventions for more advanced learners*. .

CLINICAL PROGRESSION:
IV access and monitoring already established. Obtain additional history, repeat physical exam, and provide supplemental O_2 and IV fluids as patient progresses to atrial fibrillation. ECG will indicate atrial fibrillation with RVR and participants may take one of the following courses of treatment to cardiovert patient. They should also consider administering anticoagulant (e.g. heparin).

***If participants fail to order ECG after 3 minutes of atrial fibrillation, patient will become increasingly hypotensive and less responsive. Nurse will prompt participants to obtain ECG and consult cardiology.

Option #1: Chemical cardioversion
***If participants administer AV-nodal blocking agent along with IV fluids, patient's heart rate and rhythm will revert to sinus tachycardia and vitals will read as below.

Option #2: Electrical cardioversion
***Chemical cardioversion will fail to convert rhythm. Only if participants electrically cardiovert patient, heart rate and rhythm will revert to sinus tachycardia and vitals will read as below.

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
102	140/100	37.0^o	96%	16

VII. Instructor Notes

A. Tips to keep scenario flowing
1. If need for further evaluation not recognized (Case: Part I), primary care provider will call and request cardiology consult. Cardiology consult will admit patient. If unsure of management strategy (Case: Part II), cardiology consult can call to check on their admitted patient and provide guidance with cardioversion.
2. Nurse will prompt participants to obtain ECG if not ordered after patient becomes unresponsive due to atrial fibrillation
3. *Encourage participants to develop plans independently as much as possible.*

B. Scenario programming
1. Optimal management path: Part I
- O_2/IV/monitor
- History and physical examination
- Follow rule-out MI protocol
  - Labs: CBC, BMP, cardiac markers, coagulation profile
  - Images: ECG, CXR
- IV fluid resuscitation
- Admit patient
- Order stress test and echocardiogram

2. Optimal management path: Part II
- O_2/IV/monitor (assumed present)
- Additional history and physical examination
- IV fluids
- Continue rule-out MI (optional)
- Immediate cardioversion
- Administer anticoagulant

3. Potential complications/errors path(s):
- Part I: Administration of nitrates
- Part II: Failure to obtain immediate ECG

4. Program debugging: N/A

VIII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
1. Team dynamics
   a. Leadership
   b. Collaboration
   c. Communication
   d. Professionalism
2. Didactic material: Part I
   e. Etiology/Presentation
      i. Rheumatic fever
      ii. Systolic ejection murmur
      iii. EKG criteria for LVH, demonstration of LVH strain pattern

f. Treatment
    i. Effect of nitroglycerin: increased chest pain when preload and afterload drops in setting of aortic stenosis
    ii. Role of IV fluids: increase back flow to coronary arteries
    iii. More definitive management: will need echocardiography for the diagnosis and assessment of AS severity.
    iv. Stress imaging will also be important given the need to ROMI, however, if significant AS is found on echo, together with symptoms of angina, coronary angiography should be considered, given that noninvasive tests for cardiac ischemia are less accurate in AS patients

3. Didactic material: Part II
    a. Pathophysiology
        i. LVH as a response to increased afterload
            1. Resulting S4
            2. Hypotension due to loss of atrial kick in atrial fibrillation and impaired filling of stiff ventricle
        ii. Rales: interstitium "popping open" against water surface tension
        iii. Atrial fibrillation and implications of rapid ventricular response
        iv. Troponin elevation due to leak secondary to strain from rapid ventricular response
    b. Treatment
        i. Effect of B-blocker on contractility and pressure
        ii. Urgent cardioversion to control rate given hemodynamic instability
        iii. Rate control if patient is hemodynamically stable
        iv. More thorough discussion on chemical/electrical cardioversion and aftercare
        v. Comment on classic symptoms of AS (syncope, angina, heart failure/DOE) and dramatic increase in mortality once patients become symptomatic

IX. Development and Deployment

This two step/paired case was developed as an exercise within the medical school's physiology class, and is a required experience for the entire first-year class. It has been used for several years.

X. Authors/Contributors

Case drafted by James Gordon, M.D., with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

XI. References

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Association Task Force on Practice Guidelines (Writing committee to revise the 1998 guidelines for the management of patients with valvular heart disease). J Am Coll Cardiol 2006; 48(3):e1-148.

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XII. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	142	135-147 mmol/L
Potassium	4.5	3.5-5.2 mmol/L
Chloride	97	95-107 mmol/L
CO_2	27	22-30 mmol/L
Urea Nitrogen (BUN)	13	7-20 mg/dL
Creatinine	1.2	0.5-1.2 mg/dL
Glucose	110	60-110 mg/dL

CARDIAC MARKERS		Reference Range
Part I		
Creatine Kinase-BB	0	0%
Creatine Kinase-MB (cardiac)	2.0	0 - 3.9%
Creatine Kinase-MM	98	96 – 100%
Creatine phosphokinase (CPK)	85	8 – 150 IU/L
Troponin I	0.0	≤ 0.03 ng/mL
Part II		
Creatine Kinase-BB	0	0%
Creatine Kinase-MB (cardiac)	2.3	0 - 3.9%
Creatine Kinase-MM	99	96 – 100%
Creatine phosphokinase (CPK)	101	8 – 150 IU/L
Troponin I	0.02	< 0.03 ng/mL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	35	30 – 45 sec
Prothrombin time (PT)	12	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 - 2
Fibrinogen	180	170 – 420 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	7,500	4,500 - 10,000 K/uL	
Neutrophils (%)	60	54 – 62%	
Band forms (%)	4	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.45	0 – 1%	0 - 0.75%
Eosinophils (%)	1	0 – 3%	1 – 3%
Lymphocytes (%)	30	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	14.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	40.2	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	27	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	200,000	100,000 - 450,000 K/uL	

XIII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal or mild Congestive Heart Failure
http://www.heartfailurematters.org/PublishingImages/chest_xray.jpg

ECG (Part I): Left Ventricular Hypertrophy
http://www.heartandmetabolism.org/images/HM9/hm9ccfig1.gif

ECG (Part II): Rapid AF
http://www.ecglibrary.com/af_fast.html

XIV. Appendix C: Interesting articles to discuss/reference

a) Zile, MR, Gaasch WH. *Heart failure in aortic stenosis - improving diagnosis and treatment*. N Engl J Med 2003; 348:1735.
b) Julius, BK, Spillman, M, Vassalli, et al. *Angina pectoris in patients with aortic stenosis and normal coronary arteries. Mechanisms and pathophysiologic concepts*. Circulation 1997; 95:892.
c) Vincentelli, A, Susen, S, Le Tourneau, T, et al. *Acquired von Willebrand syndrome in aortic stenosis*. N Engl J Med 2003; 349:343

Cardiogenic Shock

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter.

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Immediate ECG and portable CXR (within 10 minutes of start of case)
☐	Obtain appropriate laboratory studies: troponin, cbc, chemistry
☐	Administer immediate aspirin
☐	*Increase cardiac output with pressor agent*
☐	Administer anticoagulation medication
☐	Consult cardiology for further treatment

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants: Cardiology for EKG interpretation and management, Primary care provider if the students need prompting in general *(optional for higher level residents who can provide interpretation on their own)*

V. Case Narrative

PATIENT: 64 year old
CC: Chest pain, shortness of breath

HPI: *Use lay terminology as the voice of the patient*

Patient complains of worsening substernal chest pain over the past 3-4 hours that radiates to the left arm. Patient is short of breath, diaphoretic, and nauseated. Pain began while sitting and reading at home and is rated at a 10/10. Patient notes recent episodes of chest pain during exertion, resolving with rest.

PMHx:
Hypercholesterolemia
Hypertension

MEDICATIONS	ALLERGIES
Lipitor Atenolol	NKDA

PSHx: Denies

SOCIAL Hx:
EtOH: 10 drinks/week
Tobacco: ½ pack/day
Illicits: Denies
Occupation: Waiter/waitress
Additional: Lives with retired spouse

FAMILY Hx:
Father: Coronary Artery Disease, died of MI, age 84

ROS:
(+) Chest pain radiating to L arm, shortness of breath, nausea, diaphoresis, lightheadedness

(-) Fever/chills, vomiting, diarrhea/constipation, blurred vision, numbness/motor weakness, abdominal pain, or urinary symptoms

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
114	96/54	37.5^o	92%	18

GENERAL: A&Ox3, anxious diaphoretic
HEENT: PERRLA, EOMI, MMM
NECK: Supple, no JVD
PULM: Diffuse rales all fields
CV: Tachycardic, regular rhythm, no murmur
ABD: Soft, NT/ND, + BS, no mass/HSM

EXT: No C/C/E, palpable pulses all extremities
NEURO: No focal deficit

LABS: See Appendix A

***Pending throughout case (if participants appear to be struggling, can give them a positive troponin)

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	
Complete Blood Count (CBC)	X	Urinalysis	
CBC with differential		Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiologist – Dr. Kelly: Can help interpret EKG. Will prompt participants for aspirin, and heparin if not already given. Will also prompt for cardiac catheterization after EKG is read as ST elevation MI.

Primary Care Provider--Dr. Myers: If participants do not obtain EKG, recognize MI or do not activate catheterization lab, will call unprompted to advise EKG, rule-out MI protocol, possible cardiology consult.

CLINICAL PROGRESSION:
History and physical, IV/O_2/monitor with immediate aspirin, stat portable CXR and ECG indicative of anterior MI. Consider intubation if necessary to maintain O_2 saturation (however, be prepared for a large portion of the debriefing to focus on airway management for this—avoid clinical indications for intubation if you want to avoid this). After physical exam and ECG reading, participants should activate catheterization lab and administer alpha/beta agonists (pressor agent and ino/chronotropes), and anticoagulants.

If O_2 not provided or IV fluids initiated, patient complains of worsening shortness of breath:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
116	96/54	37.5^o	88%	22

If diuretics, nitroglycerin, morphine, or B-blocker given, patient complains of lightheadedness:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
120	80/50	37.5^o	90%	18

If pressor agent given (except if phenylephrine by itself), blood pressure increases and patient improves:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
110	110/64	37.5^o	94%	16

VI. Instructor Notes

A. Tips to keep scenario flowing

1. If students are unsure of pathology, instructor can prompt the students to create differential diagnosis and lead them towards imaging and laboratory studies necessary to confirm diagnosis.

B. Scenario programming

1. Optimal management path:
   - O_2/IV/monitor
   - History and physical examination
   - Immediate aspirin
   - Appropriate lab workup: CBC, BMP, cardiac markers, coagulation profile
   - Appropriate imaging: stat portable CXR, ECG within 10 minutes
   - *Recognize shock and administer pressor agent (e.g. Dopamine)*
   - Administer anticoagulation medication (e.g. Heparin)
   - Consult cardiology *and request to activate catheterization lab*
2. Potential complications/errors path(s):
   - Failure to administer O_2
   - Administering over 500 CC's IV fluid
   - Administering large dose of Nitroglycerin, B-blocker, Morphine
3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
1. Team dynamics
   a. Leadership
   b. Collaboration
   c. Communication
   d. Professionalism
2. Didactic material
   a. Shock pathophysiology
      i. Define shock: Perfusion insufficient to meet metabolic demand (often noted by low blood pressure < 90, MAP < 65, or other markers e.g. lactic acid)
      ii. Blood pressure is factor of heart rate, stroke volume, systemic vascular resistance.

b. Different types of shock
    i. Volume problem: Hypovolemic (eg, - Hemorrhagic)
    ii. Pump problem: Cardiogenic
    iii. Other problem: Septic, Neurogenic, Anaphylactic
c. Cardiogenic shock: presentation and etiology
d. Treatment *Can just focus on cardiogenic shock, but also may want to compare to treatment of other types of shock, such as septic shock written below*
    i. Septic shock: infection/systemic inflammatory response leading to decreased vascular tone and capillary leakage leading to depleted intravascular volume
        1. Fill 'tank'- add volume until MAP >65 or tank full [CVP 8-12]
        2. If tank adequately filled [CVP] but not enough to maintain blood pressure, increase tone with pressors
        3. Source control: identify causative agent and treat early
    ii. Cardiogenic shock: Pump problem. CO = SV x HR
        1. Increase CO [remember that HR and SV are related factors]
        2. Address underlying cause of pump failure (e.g. STEMI → reperfusion/cath)
        3. Medications:

		Receptors		
		Alpha (1)	Beta 1	Beta 2
		Vasoconstriction "pressors"	Contractility/HR, vaso/bronchodilation "ino-/chrono-tropes"	
Drugs	Epinephrine	++++	++++	++
	Norepi/Levophed	++++	++	0
	Phenylephrine/Neo	++++	0	0
	Dobutamine*	0	++++	++
	Dopamine	ALL, in dose dependent fashion B2, B1, then Alpha as dose increases		

*Not technically a "pressor" as it lacks Alpha-1 properties

***NOTE: Teaching points in addition to shock can include EKG reading and treatment for ACS

VIII. Development and Deployment

This case was developed for a widely subscribed fourth year medical school elective (emergency medicine/transition to internship), and has been used over several years as part of an instructional module on the physiology and management of shock.

IX. References

Jones, Alan E, and Jeffrey Kline. "Chapter 4 – Shock." Rosen's emergency medicine : concepts and clinical practice.—6th ed. Marx, J, ed, Mosby Elsevier, 2006.

Rivers E, Nguyen B, Havstad S, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med. 2001 Nov 8;345(19):1368-77.

X. Authors/Contributors

Case drafted by Tania Fatovich, M.D., with contributions and updates by the Gilbert Simulation Team
Compiled and formatted by Elan Guterman
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

XI. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	137	135-147 mmol/L
Potassium	3.9	3.5-5.2 mmol/L
Chloride	105	95-107 mmol/L
CO_2	27	22-30 mmol/L
Urea Nitrogen (BUN)	15	7-20 mg/dL
Creatinine	1.1	0.5-1.2 mg/dL
Glucose	103	60-110 mg/dL

CARDIAC MARKERS		Reference Range
Creatine Kinase-BB	0%	0%
Creatine Kinase-MB (cardiac)	2.0%	0 - 3.9%
Creatine Kinase-MM	98%	96 – 100%
Creatine phosphokinase (CPK)	144	8 – 150 IU/L
Troponin I	0.01	$\leq$ 0.03 ng/mL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	35	30 – 45 sec
Prothrombin time (PT)	12	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 – 2
Fibrinogen	180	170 – 420 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	9,700	4,500 - 10,000 K/uL	
Neutrophils (%)	57	54 – 62%	
Band forms (%)	8	3 - 5 (>8% indicates L shift)	

Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	15.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	92	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	34	31 – 37 g/dL	
Platelet	420,000	100,000 - 450,000 K/uL	

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Diffuse cardiogenic pulmonary edema bilaterally
http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/diffuse/Dscn017.jpg

ECG:
http://upload.wikimedia.org/wikipedia/commons/1/11/12_lead_generated_anterior_MI.JPG

XIII. Appendix C: Teaching Materials

Angioplasty Video
http://www.youtube.com/watch?v=gcrLzOkACgk&feature=channel

Inferior Myocardial Infarction

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter.

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Obtain appropriate laboratory studies: cardiac biomarkers
☐	Immediate ECG (within 10 minutes of start of case)
☐	Stat portable CXR
☐	Administer aggressive IV fluids
☐	Administer immediate aspirin
☐	*Administer pressor agent*
☐	Administer anticoagulation medication
☐	Consult cardiology for further treatment

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values
   3. Images
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG, recommends treatment plan

V. Case Narrative

PATIENT: 62 year-old
CC: Mid-epigastric discomfort

HPI: *Use lay terminology as the voice of the patient*

Patient presents with 2 hours of mid-epigastric pain that is not relieved by antacids. Pain began while patient was out walking. Patient has had similar "ulcer" symptoms while working in the yard or walking up stairs during the past few weeks. This time, the pain is not going away and is non-radiating.

PMHx:
GERD
IDDM

MEDICATIONS	ALLERGIES
Insulin Ranitidine	Penicillin

PSHx: Denies

SOCIAL Hx:
EtOH: Occasional
Tobacco: 1 pack/day, x30 years
Illicits: Denies
Occupation: Accountant

FAMILY Hx:
Brother: MI at age 55

ROS:
(+) Substernal chest pain, diaphoresis, nausea, dyspnea

(-) No fever, chills, palpitations, vomiting, headache, blurred vision, numbness/motor weakness, melena, blood in stools or urinary symptoms

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sat (RA)	RR
40	90/50	37.0^o	97%	24

GENERAL: A&OX3, uncomfortable
HEENT: WNL
NECK: Mild JVD
PULM: CTAB
CV: Bradycardic, regular rhythm, no murmur/rub/gallop
ABD: Soft, NT/ND, +BS

EXT: No C/C/E, palpable pulses all extremities
NEURO: WNL, MAE X 4, grossly intact, anxious during exam

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	
Complete Blood Count (CBC)	X	Urinalysis	
CBC with differential		Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiology – Dr. Jones: ECG will be read as STEMI in inferior leads. Cardiology will recommend preparing the patient for cardiac catheterization: Aspirin, Plavix, heparin, and "if it's safe in light of the patients' vital signs," nitroglycerin. Indicate that the patient needs to be stabilized prior to catheterization. Ask the students to notify the patient of the catheterization procedure.

Cardiology can also suggest giving atropine and/or transcutaneous pacing for bradycardia.

If vitals have not been stabilized, tell participants to call back after blood pressure and other vitals improve. If participants ask about increasing the pressure safely, recommend IV fluids.

Cardiology consultant will encourage participants to establish diagnosis and management plan themselves, providing guidance with medication recommendations.

Radiology – Dr. Smith: CXR will be read as normal x-ray. *(advanced participants should interpret)*

CLINICAL PROGRESSION:
History and physical, IV/O_2/monitor with immediate aspirin, stat portable CXR and ECG indicative of inferior MI. Students should start aggressive reperfusion with 2 liters of Normal Saline after physical exam and ECG reading as well as administer pharmacologic therapy *including pressor agent* if hypotension persists, and anticoagulants. Students should consider administering atropine and must discuss further treatment with interventional cardiology and admit patient to catheterization lab.

*** If IV fluids given, raise blood pressure to 110/70:

HR	BP	Temperature (^oC)	O_2 Sat (RA)	RR
40	110/70	37.0^o	97%	16

***If Atropine given or pacing started, patient will begin to feel better and heart rate and blood pressure will increase:

HR	BP	Temperature (^oC)	O_2 Sat (RA)	RR
60	105/70	37.0^o	97%	18

*** If Morphine and Nitroglycerin given (sublingual or IV) drop BP and patient becomes increasingly less responsive.

HR	BP	Temperature (^oC)	O_2 Sat (RA)	RR
40	70/40	37.0^o	97%	12

***If B-blockers given, decrease the heart rate to 30 BPM, drop BP into the upper 60's and pt becomes unresponsive.

HR	BP	Temperature (^oC)	O_2 Sat (RA)	RR
30	70/40	37.0^o	97%	16

VI. Instructor Notes

A. Tips to keep scenario flowing
   1. If students are unsure of pathology, instructor can prompt the students to create differential diagnosis and lead them towards imaging and laboratory studies necessary to confirm diagnosis
   2. If IV fluids not provided, nurse can verbalize need for supportive care as patient becomes increasingly hypotensive

B. Scenario programming
   1. Optimal management path:
      - O_2/IV/monitor
      - History and physical examination
      - Aggressive IV fluid resuscitation with 2 large bore IV's
      - Immediate aspirin
      - Appropriate lab workup: CBC, BMP, cardiac markers, coagulation profile
      - Appropriate imaging: stat portable CXR, ECG within 10 minutes
      - *Administer pressor*
      - Administer anticoagulation medication (e.g. Heparin)
      - Consider administering atropine
      - Consult cardiology for further treatment
   2. Potential complications/errors path(s):
      - Failure to administer IV fluids
      - Administering large dose of Nitroglycerin, B-blocker, Morphine

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
    1. Team dynamics
        a. Leadership
        b. Collaboration
        c. Communication
        d. Professionalism
    2. Didactic material
        a. Presentation
            i. Varying presentation of MI in different locations of heart; importance of preload dependent inferior MIs
            ii. Similarity in presentation of inferior MI and peptic ulcer disease or "indigestion"
        b. Pathophysiology
            i. Atherosclerotic vs. nonatherosclerotic causes
            ii. Laboratory results: troponin, CK levels and why they would be normal in setting of acute infarct
        c. Treatment
            i. Need for immediate diagnosis and reperfusion for the acute MI
            ii. Role of IV fluids in the hypotensive patient with suspected inferior/right ventricle infarct
            iii. Role of aspirin therapy: decrease mortality and reinfarction rates
            iv. Role of atropine for symptomatic bradycardia in inferior MI (and pathophysiology behind bradycardia)
            v. Role of pressors in an inferior MI patient
            vi. Role of anticoagulation *(literature regarding heparin vs low weight molecular heparin)*
            vii. Role of acute beta-blockade, nitrates, and morphine
                1. B-blocker: heart rate control and resultant decrease of myocardial O_2 demand to reduce rates of reinfarction, recurrent ischemia and potentially mortality
                2. Nitrates: preload reduction and symptomatic relief but no apparent impact on mortality rate
                3. Contraindications in the hypotensive MI patient
            viii. Role of platelet glycoprotein (GP) IIb/IIIa-receptor antagonist
            ix. Discussion of Right sided EKG
            x. Treatment options: thrombolytic therapy vs. heart catheterization (PCI) vs. coronary bypass graft

VIII. Development and Revisions

This case, along with it precursors (reference Gordon, below) and variants have been used over several years for a wide range of students, including high school, college, masters/PhD candidates, medical students (preclinical and clinical) and resident trainees. The presentation and progression is tailored to the level of the learner; often the Anterior MI case is paired with the Inferior MI case to allow students to

compare and contrast diagnosis, anatomy, physiology, and management. It is commonly used as part of a "train the trainer" curriculum for faculty development in the use of simulation.

IX. Authors/Contributors

Case drafted by the Gilbert Simulation Team, with group contributions and updates.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

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X. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	137	135-147 mmol/L
Potassium	3.9	3.5-5.2 mmol/L
Chloride	105	95-107 mmol/L
CO_2	27	22-30 mmol/L
Urea Nitrogen (BUN)	15	7-20 mg/dL
Creatinine	1.1	0.5-1.2 mg/dL
Glucose	103	60-110 mg/dL

CARDIAC MARKERS		Reference Range
Creatine Kinase-BB	0%	0%
Creatine Kinase-MB (cardiac)	2.0%	0 - 3.9%
Creatine Kinase-MM	98%	96 – 100%
Creatine phosphokinase (CPK)	100	8 – 150 IU/L
Troponin I	<0.03	$\leq$ 0.03 ng/mL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	35	30 – 45 sec
Prothrombin time (PT)	12	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 - 2
Fibrinogen	180	170 – 420 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	9,700	4,500 - 10,000 K/uL	

Neutrophils (%)	57	54 – 62%	
Band forms (%)	4	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	15.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	92	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	34	31 – 37 g/dL	
Platelet	420,000	100,000 - 450,000 K/uL	

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.med.yale.edu/intmed/cardio/imaging/findings/normal_chest_pa2/index.html
http://www.rctradiology.com/icons/normalchest.jpg

ECG: Inferior STE, bradycardia
http://1.bp.blogspot.com/_ES0GyVWZYyw/TKoO-tvelRI/AAAAAAAAAaw/gxeujTTZ8FA/s1600/Inferior+STEMI+due+to+Circumflex+occlusion.jpg

XII. Appendix C: Teaching Materials

Angioplasty Video
http://www.youtube.com/watch?v=gcrLzOkACgk&feature=channel

XIII. Appendix C: Interesting articles to discuss/reference

a) Canto J, et al. *Prevalence, Clinical Characteristics, and Mortality Among Patients With Myocardial Infarction Presenting Without Chest Pain*. JAMA Jun 28 2000; 283 (24): 3223 – 3229.
b) Henrigues J, et al. *Primary Percutaneous Coronary Intervention Versus Thrombolytic Treatment: Long Term Follow Up According to Infarct Location*. Heart Jan 2006; 92 (1): 75 – 79.

c) Mahaffey K, et al. High-Risk Patients with Acute Coronary Syndromes Treated with Low-Molecular-Weight or Unfractionated Heparin: Outcomes at 6 months and 1 year in the SYNERGY trial. JAMA Nov 23 2005; 294 (20): 2594 – 2600.
d) Antman EM et al. *ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction: Executive Summary*. J Am Coll Cardiol 2004;44:671-719.
e) Gordon, JA. Macy Cases for Realistic Patient Simulation in Critical Care and Emergency Medicine. Harvard Medical School, Boston: President and Fellows of Harvard College, 2002

Pulmonary Embolism

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Obtain laboratory studies: cbc, chemistries, troponin, coagulation studies
☐	Obtain imaging: chest xray, Chest CT angiogram
☐	Administer anticoagulant

III. Environment

A. Simulation room set up: Part I in emergency department, Part II on medical floor or emergency department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*

   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG, recommends treatment plan

V. Case Narrative: Part I

PATIENT: 68 year old
CC: Chest pain, shortness of breath

HPI: *Use lay terminology as the voice of the patient*

Patient presents with mild left-sided chest pain and significant dyspnea that began while working on computer in the morning. Patient reports that he had recently been traveling on business across the country. Chest pain is worsened by taking in a deep breath, sharp in nature.

PMHx:
COPD
Hypertension

MEDICATIONS	ALLERGIES
Albuterol Spiriva HCTZ Lisinopril	NKDA

PSHx: Denies

SOCIAL Hx:
EtOH: Occasional
Tobacco: 1-2 pack/day, x 40 years
Illicits: Denies
Occupation: Patent lawyer
Additional: Married, lives with spouse

FAMILY Hx: Unremarkable

ROS:
(+) Chest pain, dyspnea, diaphoresis

(-) Nausea, vomiting, fever/chills, diarrhea/constipation, headache, blurred vision, lightheadedness, palpitations, numbness/motor weakness, abdominal pain, or urinary symptoms

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
115	120/70	37.5^o	84%	24

GENERAL: A&Ox3, well-appearing, no acute distress
HEENT: Unremarkable, MMM
NECK: Supple, no JVD
PULM: bilateral wheeze
CV: Tachycardic, regular rhythm, no murmur

ABD: Soft, NT/ND, + BS, no mass/HSM
EXT: No C/C/E, palpable pulses all extremities
NEURO: No focal deficit

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas	X	Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	

Additional Labs: D-Dimer

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiologist-Will suggest EKG, can help interpret EKG, will suggest admitting for rule-out MI

Pulmonologist-Will suggest ABG.

CLINICAL PROGRESSION:
History and physical, IV access, supplemental O_2 and monitor. Participants must build an appropriate differential diagnosis, order any laboratory studies and images, and decide whether to admit patient. Cardiology consult will advise participants to admit for rule out MI (with ambiguity over CAD vs. COPD vs. CHF vs. PNA vs. PE).

***If participants administer supplemental O_2 along with nebulized β-agonist (albuterol), antimuscarinic (Ipratropium) or epinephrine, wheezing improves but patient remains dyspneic and cannot maintain O_2 saturation on room air:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
120	120/70	37.5^o	90%	22

***If participants order chest CT, (with or without ordering D-Dimer first) pulmonary embolism will be confirmed.

***If participants do not consider chest CT, cardiology consult will lead participants to admit patient for routine rule-out MI and COPD exacerbation.
Debriefing of Part I can occur prior to Part II. Suggestions for debriefing topics listed after Part II.

VI. Case Narrative: Part II

***Patient name, past medical history, social and family history as above.

CC: Worsening shortness of breath, lightheadedness

HPI: *Use lay terminology as the voice of the patient*

Patient is now on the inpatient ward with a diagnosis of chest pain rule-out MI and COPD (or perhaps a diagnosis of pulmonary embolism if the participants got that far). Patient is complaining of lightheadedness and has a declining level of consciousness.

As patient is complaining (3-5 minutes), patient has a PEA arrest.

ROS: As above, apart from increasing lightheadedness.

PHYSICAL EXAM: Physical findings as above

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
130	80/50	37.5^o	76%	28

*******Labs and images available are listed above.

CONSULTS:
Cardiology-Suggest to go through the "H's and T's" for cause of PEA.

Advanced participants may consider cardiology consultation for stat echocardiogram or cardiothoracic surgery for embolectomy.

CLINICAL PROGRESSION:
Participants must re-examine patient, obtain any additional history, and re-initiate O_2 therapy. As patient falls into PEA arrest, participants must perform immediate CPR. If started, after one round of chest compressions, the patient will recover a blood pressure, previous vitals will return, and anti-coagulation and/or TPA should be ordered, and case will end.

***If supplemental O_2 is provided, patient improves slightly but O_2 saturation stays below 90%

EKG and CXR if ordered are unchanged. Cardiac enzymes are negative. Oxygen helps some but not enough to get the O2 sat into the 90s.

VII. Instructor Notes

A. Tips to keep scenario flowing
   1. Cardiology or pulmonary consult can be used to prompt participants to admit patient in Part I of case if they appear unsure about further management.

B. Scenario programming
   1. Optimal management path:
      - O_2/IV/monitor
      - History and physical examination

- Appropriate lab workup: CBC, BMP, cardiac enzymes, coagulation profile, D-Dimer
- Appropriate imaging: CXR, ECG, CT angiography (Chest)
- Administer anticoagulant (e.g. Heparin)

2. Potential complications/errors path(s):
   - Failure to initiate O_2 therapy
3. Program debugging: N/A

VIII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
   1. Team dynamics
      a. Leadership
      b. Collaboration
      c. Communication
      d. Professionalism
   2. Didactic material
      a. Part I:
         i. Differential diagnosis of chest pain
         ii. Differential diagnosis of shortness of breath
      b. Part II
         i. Diagnosis
            1. Decision Support (PERC score, Well's criteria)
            2. D-Dimer, CT angiography, V/Q scan
            3. EKG findings (sinus tachycardia, uncommon RV strain pattern: S1Q3T3)
         ii. Treatment
            1. Anti-coagulation vs thrombolysis vs embolectomy

IX. Development and Deployment

This case was developed for second-year medical students as part of a core respiratory physiology/pathophysiology class, and has been used as teaching module for third-year clerkship students.

X. Authors/Contributors

Case drafted by Emily Hayden, M.D., with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

XI. References

a) Kline, Jeffrey, and Michael Runyon. "Chapter 87 – Pulmonary Embolism and Deep Venous Thrombosis." Rosen's Emergency Medicine: Concepts and Clinical Practice : 6th ed. Marx, J, ed. Mosby, 2006.
b) Kline JA, et al: Clinical criteria to prevent unnecessary diagnostic testing in emergency department patients with suspected pulmonary embolism. J Thromb Haemost 2004; 2:1247.
c) Wells PS, et al: Excluding pulmonary embolism at the bedside without diagnostic imaging: Management of patients with suspected pulmonary embolism presenting to the emergency department by using a simple clinical model and D-dimer. Ann Intern Med 2001; 135:98.

XII. Appendix A: Lab Values

Part I (Room Air) ARTERIAL BLOOD GAS		Reference Range
pH	7.40	7.35-7.45
pCO_2	39	35-45 mmHg
pO_2	70	60-100 mmHg

BASIC METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	4.1	3.5-5.2 mmol/L
Chloride	102	95-107 mmol/L
CO_2	34	22-30 mmol/L
Urea Nitrogen (BUN)	12	7-20 mg/dL
Creatinine	0.8	0.5-1.2 mg/dL
Glucose	110	60-110 mg/dL

CARDIAC MARKERS		Reference Range
Creatine Kinase-MB (cardiac)	1.5	0 - 3.9%
Creatine phosphokinase (CPK)	100	8 – 150 IU/L
Troponin I	< 0.03	$\leq$ 0.03 ng/mL
D-Dimer	1325	<250 ng/ml

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	31	30 – 45 sec
Prothrombin time (PT)	10	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 - 2

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	7.8	4,500 - 10,000 K/uL	

Hemoglobin (HGB)	15	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	45	41 – 50%	36 – 44%
Red blood cell (RBC)	5.0	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
Platelet	225	100,000 - 450,000 K/uL	

XIII. Appendix B: Diagnostic Studies

Chest X-Ray: Hyperinflation
http://images.radiopaedia.org/images/266487/d35992af9e42aba7d71001c13843c3_gallery.jpg

CT with Angiography

Image courtesy of Dr Jeffrey Siegelman, Massachusetts General Hospital

ENDOCRINE CASES

Gilbert Program in Medical Simulation

Harvard Medical School

Alcoholic Ketoacidosis

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	IV glucose
☐	IV fluids

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG

V. Case Narrative

PATIENT: 56 year old
CC: Vomiting, chills, acute abdominal pain

HPI: *Use lay terminology as the voice of the patient*

Patient presents with uncontrollable nausea and vomiting with acute abdominal pain. Patient claims to not have been able to keep food down for two days. "Maybe something I ate?"
The patient denies diarrhea.

PMHx:
Denies diabetes, blood pressure, heart issues

MEDICATIONS	ALLERGIES
Denies	Penicillin

PSHx: Denies

SOCIAL Hx:

EtOH: Needs to be asked directly and pressed to admit alcohol use. Eventually admits history of alcohol abuse or nurse will relate the fact from past hospital admission records. "I haven't had a drop in over two days." Eventually admits a binge three days ago at a friend's house. "He bought some of this fancy black rum thing."
Tobacco: Occasional
Illicits: Vigorously denies, latches on to that part of the question
Occupation: Temp secretary, registered with a local agency but is currently "between assignments."
Additional: Lives alone

FAMILY Hx: Unremarkable

ROS:
(+) Nausea, vomiting, abdominal pain, dyspnea, dizziness

(-) Muscle pain, diarrhea, syncope, seizure, or melena

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
112	90/50	36.0^o	99%	24

GENERAL: In mild distress, but nontoxic appearing, smelling of ketones (nail polish remover on cotton balls, placed by the head of the mannequin)
HEENT: Dry mucous membranes
NECK: Supple, no JVD
PULM: Clear to auscultation bilaterally

CV: Tachycardic but regular
ABD: Soft, ND, diffusely tender, + BS
EXT: No C/C/E, palpable pulses all extremities
NEURO: MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas	X	Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	X
Complete Blood Count (CBC)	X	Urinalysis	X
CBC with differential		Urine HCG	

Additional Labs: serum ketone levels

IMAGES: See Appendix B

Angiogram		ECG	
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CLINCAL PROGRESSION:
History and physical, IV access, supplemental O_2 and monitor. Participants must recognize likely acidosis, administer thiamine, check fingerstick glucose, administer glucose/dextrose, and order appropriate laboratory studies. Dehydration should be recognized and IV fluids should also be initiated promptly. Once completed, patient's symptoms will resolve and participants must admit patient. Without glucose/dextrose or IV fluids, patient's acidosis will worsen throughout case, patient will become more obtunded with worsening tachypnea and tachycardia.

VI. Instructor Notes

A. Tips to keep scenario flowing
1. If students are unsure of pathology, instructor can prompt the students to create differential diagnosis and lead them towards imaging and laboratory studies necessary to confirm diagnosis.
2. If IVF are not provided, nurse can verbalize patient's appearance of dehydration or note increasing tachypnea.

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor
- History and physical examination
- Appropriate lab work up: BMP, CBC, UA, ABG, toxicology screen, serum ketones

- Aggressive IV fluid resuscitation
- Thiamine administration
- Dextrose/glucose administration
- Correct electrolyte imbalances
- Imaging as indicated (CXR)

2. Potential complications/errors path(s):
   - Failure to administer dextrose/glucose
   - Failure to administer IVF
   - Failure to recognize acidosis
3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
   1. Team dynamics
      a. Leadership
      b. Collaboration
      c. Communication
      d. Professionalism
   2. Didactic material
      a. Presentation/Etiology
         i. Appropriate differential diagnosis
         ii. Abdominal pain, nausea/vomiting is common and nonspecific
         iii. Breath can have fruity odor, indicating ketonemia
         iv. Understanding respiratory compensation
      b. Pathophysiology
         i. Emphasize NADH/NAD ratio, normal glucose, depleted carbohydrate and protein stores, elevated fatty acids
         ii. Compare and contrast with DKA and starvation ketosis
         iii. Understand why glucose can be low/high/normal
         iv. Understand why ketonuria but little/no glucosuria
         v. Importance to consider and distinguish among ethanol, methanol and ethylene glycol toxicity
         vi. Anion gap: Na - ($Cl + HCO_3$)
      c. Treatment
         i. Proper laboratory evaluation – considering all etiologies of metabolic acidosis, consider evaluating for osmolar gap
         ii. Need for vitamin supplementation (thiamine), careful repletion of electrolytes
         iii. *Discussion of thiamine before glucose and potential to increase the risk of precipitating Wernicke's encephalopathy/Korsakoff's syndrome (evidence for/against)*
         iv. Avoidance of insulin administration for the ketosis
         v. Avoidance of bicarbonate administration for the acidosis

VIII. Development and Deployment

This case was developed as part of a graduate-level science course (college, PhD students), and has been deployed as a recurrent course offering.

IX. Authors/Contributors

Case drafted by Julia Khodor, Ph.D. with Emily Hayden, M.D.; additional contributions and updates by the Gilbert Simulation Team. Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

ARTERIAL BLOOD GAS		Reference Range
pH	7.13	7.35-7.45
pCO_2	18	35-45 mmHg
pO_2	84	60-100 mmHg
HCO_3	16	24-28 mmol/L
Sa O_2	99	97-100%
FiO_2	.21	.21

Anion gap: 26 (7-13)

BASIC METABOLIC PANEL		Reference Range
Sodium	140	135-147 mmol/L
Potassium	3.3	3.5-5.2 mmol/L
Chloride	104	95-107 mmol/L
CO_2	10	22-30 mmol/L
Urea Nitrogen (BUN)	45	7-20 mg/dL
Creatinine	1.5	0.5-1.2 mg/dL
Glucose	120	60-110 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	7,000	4,500 - 10,000 K/uL	
Neutrophils (%)	59	54 – 62%	
Band forms (%)	4	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.35	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	12.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	36.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.0	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	16.0	< 14.5%	
MCV	105	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	33	31 – 37 g/dL	

Platelet	150,000	100,000 - 450,000 K/uL

SERUM KETONES		Reference Range
Beta Hydroxybutyrate	Very high	0-0.3
Acetoacetate	Very high	0.3-2.0

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	<10	<10
Salicylates	<5	<5
EtOH	0	0
Opiates	Negative	Negative
Cocaine Metabolites	Negative	Negative
Benzodiazepines	Negative	Negative
Cannabis Derivatives	Negative	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

URINALYSIS		Reference Range
Color	Pale yellow	Pale to dark yellow, amber
pH	7.3	5 – 8
Specific gravity	1.002	1.002 – 1.035
Protein	Negative	Negative/trace
Glucose	Negative	Negative
Ketones	Positive	Negative
Nitrites	Negative	Negative
Bilirubin	Negative	Negative
Blood	Negative	Negative
Leukocyte	Negative	Negative

Urobilinogen	0.3	0.2 – 1.0 Ehr U/L
HCG	0	0 – 5 IU/L

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

XII. Appendix C: Interesting articles to discuss/reference

a) Wrenn, KD, Slovis, CM, Minion, GE, Rutkowski, R. *The syndrome of alcoholic ketoacidosis.* Am J Med 1991; 91:119.

b) Marinella MA. *Alcoholic ketoacidosis presenting with extreme hypoglycemia*. Am J Emerg Med. May 1997;15(3):280-1.

c) Hojer, J. *Severe metabolic acidosis in the alcoholic: differential diagnosis and management*. Hum Exp Toxicol 1996; 15:482.

d) Miller, PD, Heinig, RE, Waterhouse, C. Treatment of alcoholic acidosis. *The role of dextrose and phosphorus*. Arch Intern Med 1978; 138:67.

Diabetic Ketoacidosis: New Onset Diabetes Mellitus Type I

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	Obtain appropriate laboratory: cbc, chemistries, blood gas
☐	IV fluid resuscitation
☐	Insulin drip

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values
   3. Images
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Endocrinologist: will recommend laboratory studies and ICU consult
   2. Intensivist: will recommend management and admit patient to ICU

V. Case Narrative

PATIENT: 19 year old
CC: Abdominal pain, vomiting

HPI: *Use lay terminology as the voice of the patient*

Patient presents complaining of nausea, vomiting, and abdominal pain which started last night. Patient reports feeling weak, confused, and thirsty for the last 3 days. Patient is actively throwing up during the H&P. When asked about abdominal pain, patient reports pain is diffuse, does not localize and does not migrate. Patient reports onset of subjective fever this morning after waking up (did not take temperature). Patient denies any recent illness, change in diet, foreign travel, chemical exposure or sick contacts.

If asked, patient reports urinating more frequently in the last 2-3 days. Denies dysuria.

PMHx:
Denies

MEDICATIONS	ALLERGIES
Denies	Penicillin

SOCIAL Hx:
ETOH: Occasional
Tobacco: Denies
Illicits: Denies
Occupation: Auto mechanic
Additional: Lives alone

FAMILY Hx:
Adopted, does not know family history.

ROS:
(+) Fever, nausea, vomiting, abdominal pain, increased urinary frequency, shortness of breath, polydipsia over last three days until last night

(-) No chest pain, headache, neck pain, cough, dysuria, diarrhea/constipation, blood in stool, hematemesis

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature	O_2 Sats (RA)	RR
140	80/60	37.5	96%	30

GENERAL: Alert to person, place only (A&Ox2).
HEENT: Dry mucous membranes, neck supple, no meningismus
CV: Tachycardic, no murmurs
PULM: Rapid deep breaths, clear to auscultation
ABD: Diffuse tenderness, no localizing pain, soft, non-distended, + BS.

EXT: No edema, distal pulses palpable
NEURO: WNL

LABS: See Appendix A

Amylase/Lipase Level	X	Comprehensive Metabolic Panel	
Arterial Blood Gas	X	Hepatic Panel	X
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	X
Complete Blood Count (CBC)		Urinalysis	X
CBC with differential	X	Urine HCG	

Additional Labs: serum ketone levels, lactic acid level

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast	X	X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Endocrinologist or PCP: Dr. Myers: Recommend laboratory studies (if not ordered- CBC, BMP, serum ketones), 2 liters of fluid, and insulin drip (0.1 mg/kg/hr). Recommendation for further management after ICU consult and admission

Intensivist: Dr. Adams: Recommend continued fluids, correction of electrolytes (IV potassium), additional laboratory studies/studies (lactate, toxicology screen, ECG, ABG), and admission to ICU

CLINICAL PROGRESSION:
Obtain history and physical, laboratory studies, ECG, initiate two liters of Normal Saline +/- insulin bolus, initiation of insulin drip, correction of electrolytes, discussion with PCP or endocrinologist, discussion with intensivist and admission to ICU.

***If patient sent for CT scan for abdominal pain work-up but no treatment beforehand, blood pressure and heart rate will worsen

HR	BP	Temperature	O_2 Sats (RA)	RR
160	70/50	37.5	95%	30

***Insulin (one-time dose) with fluids: If one time dose of insulin given with IV fluids, patient improves slightly but will continue to vomit:

HR	BP	Temperature	O_2 Sats (RA)	RR
132	94/60	37.5	96%	28

***Insulin (one-time dose) with no fluids: If one time dose of insulin given without IV fluids, patient continues to worsen:

HR	BP	Temperature	O_2 Sats (RA)	RR
145	82/60	37.5	96%	30

***Insulin drip: If insulin drip given with fluids, patient shows more significant improvement:

HR	BP	Temperature	O_2 Sats (RA)	RR
110	100/60	37.5	96%	20

Once appropriate initial treatment provided, can provide one hour laboratory studies showing K 3.2, glucose 350. Students are expected to add potassium to IV fluids, and to request hourly lab draws, with plan to add glucose when level < 250.

VI. Instructor Notes

A. Tips to keep scenario flowing
1. If students are unsure of pathology, prompting can come in form of a primary care physician calling to check in on their patient.
2. laboratory studiesIf supplemental O_2 is not provided, nurse can verbalize concern as patient becomes increasingly dyspneic

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor
- History and physical examination
- Appropriate lab workup: CBC, BMP, blood gas, toxicology screen, urinalysis, hepatic panel, lactic acid level, lipase level, serum ketones
- Appropriate imaging: CXR, ECG
- Aggressive IV fluid resuscitation
- Initiate insulin drip
- Correct electrolyte imbalance
- Transfer patient to ICU

2. Potential complications/errors path(s):
- Failure to administer IV fluids

3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
1. Team dynamics
   i. Leadership
   ii. Collaboration
   iii. Communication
   iv. Professionalism
2. Didactic material
   i. Pathophysiology
      1. Type I vs. Type II Diabetes
      2. Pathophysiology of ketoacidosis: under low-insulin conditions (regardless of plasma glucose level) liver acts as if body is starving and metabolizes fats, producing ketone bodies/lowering blood pH

3. Anion gap: Na - ($Cl + HCO_3$)
4. Corrected sodium: measured Na + 0.016 x (serum glucose - 100)
5. Diagnosis of DKA is not enough, need to determine precipitant
6. Comparison with HONC (Hyperosmolar Nonketotic Coma)

ii. Presentation
1. Abdominal pain, nausea, vomiting
2. Polyuria and polydipsia: osmotic diuresis
3. Kussmaul breathing with increasing acidosis: breath becomes slow and labored reducing blood CO_2
4. High blood-sugar levels and hypokalemia

iii. Etiology (infection, med non-compliance, newly diagnosed diabetes, less common MI, CVA, trauma)

iv. Treatment
1. Insulin drip
2. IV fluids
3. *Electrolyte repletion*

v. Complications
1. Hypoglycemia
2. Missing underlying infection
3. Electrolyte abnormalities

VIII. Development and Deployment

This case was developed for independent study sessions for first and second year medical students. Variants have been deployed as a required component of the second year endocrine physio/pathophysiology core module; for college and master's/PhD science courses; and as part of "transition to the wards" integration curricula for rising third year medical students.

IX. Authors/Contributors

Case drafted Case drafted by Rami Ahmed, D.O, with contributions and updates by the Gilbert Simulation Team. Compiled and formatted by Elan Guterman.
Reviewed by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. References

a) Brandenburg MA, Dire DJ. Comparison of arterial and venous blood gas values in the initial emergency department evaluation of patients with diabetic ketoacidosis. *Ann Emerg Med*. Apr 1998;31(4):459-65. (To discuss the utility of ABG over VBG)

b) Wolfsdorf J, Craig ME, Daneman D, Dunger D, Edge J, Lee WR, et al. Diabetic ketoacidosis. ISPAD Clinical Practice Consensus Guidelines 2006-2007. Pediatr Diabetes. Feb 2007;8(1):28-43 (special considerations in pediatrics, different fluid recommendations)

XI. Appendix A: Lab Values

ARTERIAL BLOOD GAS		Reference Range
pH	7.15	7.35-7.45
pCO_2	25	35-45 mmHg
pO_2	80	60-100 mmHg
HCO_3	10	24-28 mmol/L
Sa O_2	96	97-100%
FiO_2	.21	.21

BASIC METABOLIC PANEL		Reference Range
Sodium	128	135-147 mmol/L
Potassium	5.6	3.5-5.2 mmol/L
Chloride	95	95-107 mmol/L
CO_2	10	22-30 mmol/L
Urea Nitrogen (BUN)	48	7-20 mg/dL
Creatinine	1.3	0.5-1.2 mg/dL
Glucose	650	60-110 mg/dL

CHEMISTRY TESTS		Reference Range
Lactic Acid	2.0	0 – 1.5 mEq/L
Lipase	34	7 – 60 IU/L

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	16,000	4,500 - 10,000 K/uL	
Neutrophils (%)	59	54 – 62%	
Band forms (%)	6	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.35	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	28	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	15.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	45.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	150,000	100,000 - 450,000 K/uL	

HEPATIC PANEL		Reference Range	
		Age 25-60	Age >61
Albumin	4.5	3.5 – 5.0 g/dL	
Alkaline Phosphatase	76	33 – 131 IU/L	51 – 153 IU/L
Aspartate Aminotransferase (AST)	42	15-50 IU/L	
Alanine Aminotransferase (ALT)	15	6-50 IU/L	
T. Bilirubin	0.5	0.1 – 1.2 mg/dL	
D. Bilirubin	0.1	0 – 0.3 mg/dL	
Total Protein	6.9	6.3 – 8.5 g/dL	

SERUM KETONES		Reference Range
Beta Hydroxybutyrate	Very high	0-0.3
Acetoacetate	Very high	0.3-2.0

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	<10	<10
Salicylates	<5	<5
EtOH	0	0
Opiates	Negative	Negative
Cocaine Metabolites	Negative	Negative
Benzodiazepines	Negative	Negative
Cannabis Derivatives	Negative	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

URINALYSIS		Reference Range
Color	Pale yellow	Pale to dark yellow, amber
pH	7.3	5 – 8
Specific gravity	1.002	1.002 – 1.035
Protein	Negative	Negative/trace
Glucose	Very high	Negative
Ketones	Positive	Negative
Nitrites	Negative	Negative
Bilirubin	Negative	Negative
Blood	Negative	Negative
Leukocyte	Negative	Negative
Urobilinogen	0.3	0.2 – 1.0 Ehr U/L
HCG	0	0 – 5 IU/L

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

ECG: Sinus tachycardia, rate 140
http://www.emedu.org/ecg/images/st_1a.jpg

If ordered:

CT Abdomen/Pelvis: Normal

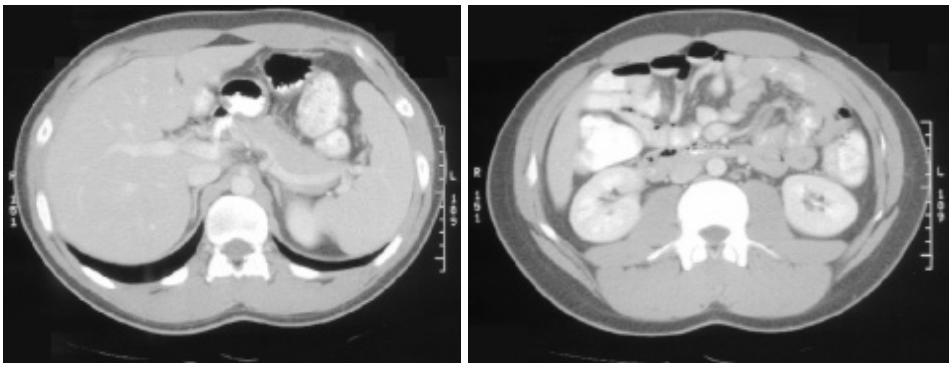

Image courtesy of Dr Jeffrey Siegelman, Massachusetts General Hospital

Hyperemesis Gravidarum

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Vital signs
☐	Patient history
☐	Physical examination
☐	IV Access
☐	Antiemetics
☐	IV fluid resuscitation
☐	Administer Insulin/glucose
☐	Obtain appropriate laboratory studies: cbc, chemistries
☐	Clearance of ketonuria

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG
   3. Ob/Gyn: recommends treatment plan

Case Narrative

PATIENT: 25 year old, female
CC: Vomiting, "I can't stop throwing up"

HPI: *Use lay terminology as the voice of the patient*

Patient complains of uncontrollable nausea and vomiting. She is 13 weeks pregnant according to her last normal menstrual period. She has been pregnant 1 time before, but did not have this much nausea and vomiting, nor did it last as long. She has tried eating when she first wakes up in the morning before she arises from bed, and also been trying ginger tea as her aunt told her it worked for her. She has not gained any weight in the current pregnancy so far, and in fact may have lost 5-8lbs since conception. This current visit to the ER was brought on by inability to keep any food down over the previous 18 hours. Patient reports trying to drink water or Gatorade, but only being successful "sometimes." If asked, she had been admitted to the hospital twice before this pregnancy, for IV fluids and "something to make me stop throwing up."

PMHx:
Denies, except for 1 uncomplicated pregnancy 2 years ago.

MEDICATIONS	ALLERGIES
Tylenol as needed	NKDA

****If asked*: Did not yet have a glucose tolerance test in this pregnancy but denies developing gestational diabetes in her first pregnancy.

PSHx: Denies

SOCIAL Hx:
EtOH: Occasional when not pregnant
Tob: Denies
Illicits: Denies
Occupation: Pharmacy tech at local CVS
Additional: Lives with boyfriend

FAMILY Hx: Unremarkable

ROS:
(+) Nausea, vomiting, diaphoresis, slight lightheadedness
(-) Denies fevers, chills, abdominal pain, diarrhea, vaginal discharge and vaginal bleeding

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature	O_2 Sats (RA)	RR
112	100/60	37.8	99%	Normal

GENERAL: Ill but nontoxic appearing, with dry mucous membranes
HEENT: PERRLA, EOMI, dry MM

NECK: Supple, No JVD
PULM: CTAB
CV: Tachycardic but regular
ABD: soft, NT/ND, uterus inferior to the umbilicus
NEURO: WNL, MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level	X	Comprehensive Metabolic Panel	
Arterial Blood Gas	X	Hepatic Panel	X
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	X
Complete Blood Count (CBC)		Urinalysis	X
CBC with differential	X	Urine HCG	

Additional Labs: serum ketone levels, lactic acid level

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	
Echocardiogram		Ultrasound	X

Additional Images: none

CONSULTS:
OB – Dr. Kelly: Confirms 2 previous hospital admissions, for fluids and antiemetics, due to continual vomiting. Recommends similar course now, with an overnight admission and lab follow ups. For now, recommends laboratory studies (if not ordered- CBC, BMP), 2 liters of iv fluids, antiemetics, NO insulin. Requests follow-up if patient does not improve.

CLINCAL PROGRESSION:
History and physical, IV fluids and antiemetics. If students provide fluids and antiemetic, patient will feel slightly better but still not able to keep fluids down. After passage of some time (30 minutes to 2 hours), blood pressure increases to 150/90, heart rate increases to 130, temperature decreases to 36.6. OB/Gyn consultation will recommend 5% dextrose IV after which the patient will improve and be admitted for observation.

V. Instructor Notes

A. Tips to keep scenario flowing
   1. If students are unsure of pathology, prompting can come in form of a primary care physician or OB/Gyn calling to check in on their patient.
   2. If IV fluids are not provided, nurse can verbalize patient's appearance of dehydration or note worsening clinical status.

B. Scenario programming
   1. Optimal management path:

- IV/monitor
- History and physical examination
- Appropriate lab workup: CBC, BMP, hepatic panel, amylase/lipase, UA, lactic acid, toxicology screen
- IV fluid resuscitation
- Dextrose administration
- Antiemetics administration
- Consult ObGyn
- Admit patient to the hospital

2. Potential complications/errors path(s):
    - Failure to administer glucose/dextrose containing fluids
    - Failure to begin IV fluid resuscitation
    - Failure to admit to hospital

VI. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
    1. Team dynamics
        a. Leadership
        b. Collaboration
        c. Communication
        d. Professionalism
    2. Didactic material
        a. Presentation
            i. Appropriately broad differential diagnosis of N/V
                1. Medications, Tox, Infectious, CNS, GI
            ii. Metabolic derangements, such as hypokalemia, metabolic alkalosis, ketonemia and ketonuria
        b. Etiology/Pathophysiology
            i. Multiple theories: hormonal changes, abnormal gastric motility/H Pylori, psychological factors
            ii. Diagnosis largely clinical (persistent vomiting accompanied by weight loss exceeding 5 percent of pre-pregnancy body weight and ketonuria in the first trimester, unrelated to other causes)
        c. Treatment
            i. Importance of IV fluid resuscitation, Glucose/Dextrose containing fluids
            ii. Discuss need for vitamin supplementation
            iii. Need for ultrasound: to confirm IUP and exclude gestational trophoblastic disease and multiple gestation (associated with hyperemesis)
            iv. Additional management: Antihistamines (benadryl, meclizine), Vitamin B6, Antiemetics (Ondansetron, Promethazine, Prochlorperazine, Metoclopramide), Antacids
            v. Discuss steroid indications
            vi. Factors determining decision to admit

d. Complications
    i. Rare, but do occur: Mallory-Weiss tears, severe dehydration/malnutrition

VII. Development and Deployment

This case was developed as part of a graduate-level science course (college, PhD students), and has been deployed as a recurrent course offering.

VIII. Authors/Contributors

Case drafted by Julia Khodor, Ph.D, with Emily Hayden, M.D.; additional contributions and updates by the Gilbert Simulation Team. Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

Initial:

ARTERIAL BLOOD GAS		Reference Range
pH	7.19	7.35-7.45
pCO_2	25	35-45 mmHg
pO_2	80	60-100 mmHg
HCO_3	8	24-28 mmol/L
Sa O_2	99	97-100%
FiO_2	.21	.21

*Anion gap 17.9 (7-13)

At initial presentation

BASIC METABOLIC PANEL		Reference Range
Sodium	141	135-147 mmol/L
Potassium	2.5	3.5-5.2 mmol/L
Chloride	98	95-107 mmol/L
CO_2	8	22-30 mmol/L
Urea Nitrogen (BUN)	36	7-20 mg/dL
Creatinine	1.4	0.5-1.2 mg/dL
Glucose	86	60-110 mg/dL

***Glu, post-consult, if no sugar provided: 68 mg/dL

CHEMISTRY TESTS		Reference Range
Lactic Acid	1.3	0 – 1.5 mEq/L
Lipase	34	7 – 60 IU/L

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	11,000	4,500 - 10,000 K/uL	

Neutrophils (%)	59	54 – 62%	
Band forms (%)	4	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.35	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	15.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	45.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	150,000	100,000 - 450,000 K/uL	

HEPATIC PANEL		Reference Range	
		Age 25-60	Age >61
Albumin	4.5	3.5 – 5.0 g/dL	
Alkaline Phosphatase	76	33 – 131 IU/L	51 – 153 IU/L
Aspartate Aminotransferase (AST)	42	15-50 IU/L	
Alanine Aminotransferase (ALT)	15	6-50 IU/L	
T. Bilirubin	0.5	0.1 – 1.2 mg/dL	
D. Bilirubin	0.1	0 – 0.3 mg/dL	
Total Protein	6.9	6.3 – 8.5 g/dL	

SERUM KETONES		Reference Range
Beta Hydroxybutyrate	Very high	0-0.3
Acetoacetate	Very high	0.3-2.0

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	<10	<10
Salicylates	<5	<5
EtOH	0	0
Opiates	Negative	Negative
Cocaine Metabolites	Negative	Negative
Benzodiazepines	Negative	Negative
Cannabis Derivatives	Negative	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

URINALYSIS		Reference Range
Color	Pale yellow	Pale to dark yellow, amber
pH	7.3	5 – 8
Specific gravity	1.002	1.002 – 1.035
Protein	Negative	Negative/trace
Glucose	Very high	Negative
Ketones	Positive	Negative
Nitrites	Negative	Negative
Bilirubin	Negative	Negative
Blood	Negative	Negative
Leukocyte	Negative	Negative
Urobilinogen	0.3	0.2 – 1.0 Ehr U/L
HCG	0	0 – 5 IU/L

XI. Appendix B: Diagnostic Studies

ECG: sinus tachycardia
http://www.emedu.org/ecg/images/st_1a.jpg

Ultrasound: Intrauterine pregnancy consistent with 13 weeks
http://www.ob-ultrasound.net/images/us13.jpg

XII. Appendix C: Interesting articles to discuss/reference

a) Holmgren, C, Aagaard-Tillery, KM, Silver, RM, et al. *Hyperemesis in pregnancy: an evaluation of treatment strategies with maternal and neonatal outcomes*. Am J Obstet Gynecol 2008; 198:56.

b) Jewell, D, Young, G. *Interventions for nausea and vomiting in early pregnancy*. Cochrane Database Syst Rev 2003; :CD000145.

c) Abell, T, Riely, C. *Hyperemesis gravidarum*. Gastroenterol Clin North Am 1992; 21:835.

d) Fell, DB, Dodds, L, Joseph, KS, et al. *Risk factors for hyperemesis gravidarum requiring hospital admission during pregnancy*. Obstet Gynecol 2006; 107:277.

Hypoglycemia

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Vital signs
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Supplemental glucose

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
C.
   1. Radiologist: reads chest x-ray and head CT, if ordered
   2. Cardiologist: reads ECG

V. Case Narrative

PATIENT: 20 year old
CC: Altered mental status

HPI: *Use lay terminology as the voice of the patient*

Patient brought in by ambulance after friends called 911 when patient was "acting funny." Patient appears intoxicated. Patient is a limited historian due to altered mental status. Patient refuses to answer the questions pertaining to the event and his/her past medical history, continually responding with inappropriate or unrelated statements and a desire to "get outta here."

***After normalization with glucose, patient calms down and reports that s/he had been out with friends all day and taken daily dose of insulin but had forgotten to eat.

PMHx:
DM Type I

MEDICATIONS	ALLERGIES
Insulin	NKDA

PSHx: Denies

SOCIAL Hx:
EtOH: Occasional
Tobacco: Rarely
Illicits: Denies
Occupation: College student
Additional: Lives in a dorm at school

FAMILY Hx: Unremarkable

ROS (initially):
(+) Altered mental status. Otherwise, impossible to retrieve.

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
114	128/70	37.0^o	98%	12

GENERAL: Atraumatic, agitated, confused
HEENT: Cheeks flushed, TM clear bilaterally, PERRL, EOMI, nares clear, OP erythematous
NECK: Supple, JVP not elevated
PULM: CTAB
CV: Tachycardia, regular rhythm
ABD: Soft, NT/ND, no masses, +BS
EXT: No C/C/E, palpable pulses all extremities

NEURO: Increasingly unresponsive, moving all extremities, not following commands but does withdraw to pain

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	X
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel		Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	X
Complete Blood Count (CBC)		Urinalysis	X
CBC with differential	X	Urine HCG	

Additional Labs: per facilitator's discretion, fingerstick

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast	X	X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:

***Lab technician: can call for critical value of glucose to prompt treatment (either after or before to guide away from intubation depending on timing needs.)

CLINICAL PROGRESSION:
Patient history can only be elicited after normalization with glucose. Physical examination is difficult to complete, patient will not accept non-rebreather mask but can gain IV access and hook up to monitor.

If participants give glucose as a bolus (not just glucose added to IV fluids), patient normalizes and can give history.

If participants fail to give glucose in first 5-10 minutes of case—or they only give glucose as D5 in a liter of fluids, patient has worsening mental status to the point of unresponsiveness with decreased respiratory rate and an O_2 saturation possibly requiring intubation*:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
120	110/70	37.0^o	93%, decreasing	7

*To avoid intubation, see consult above or notes below

Possible addition to case: hypoglycemic seizure – if participants have already thought about glucose and can promptly treat patient.

VI. Instructor Notes

A. Tips to keep scenario flowing
   1. Nurse can ask which laboratory studies to send, and prompt for a fingerstick

B. Scenario programming
   1. Optimal management path:
      - O_2/IV/monitor
      - History and physical examination
      - Dextrose IV
   2. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
   1. Team dynamics
      a. Leadership
      b. Collaboration
      c. Communication
      d. Professionalism
   2. Didactic material
      a. Presentation: history includes HA, confusion, sweating, anxiety, tremor, nausea, and somnolence.
      b. Etiology: DDx includes electrolyte abnormalities (Hyper and hyponatremia, hypercalcemia), hypoglycemia, uremia, hepatic encephalopathy, infection, trauma, toxic ingestion, hypoxia, hypercarbia, primary neurologic process
      c. Pathophysiology
      d. Treatment
         i. Type of glucose administration (ampule of D50 vs. D5 in fluids)
      e. Complications (obtundation with respiratory compromise, seizure)

VIII. Development and Deployment

This case was developed for a widely subscribed fourth year medical school elective (emergency medicine/transition to internship), and variants have been used over several years as part of an instructional module for the physiology and management of altered mental status.

IX. Authors/Contributors

Case drafted by Tania Fatovich, M.D., with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

Labs pending during case or if prefer- can give normal laboratory studies except for glucose. [Can discuss after the case what lab abnormalities could explain a change in MS.] FS can be available if requested.

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

ECG: Sinus tachycardia, rate 140
http://www.emedu.org/ecg/images/st_1a.jpg

Rhabdomyolysis

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Obtain appropriate laboratory studies: cbc, chemistries, total CK, UA
☐	IV fluid resuscitation
☐	Appropriate treatment of hyperkalemia
☐	Monitor urine output
☐	Cooling

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG
   3. Primary care provider, can provide background information
   4. Nephrologist, recommends treatment plan
   5. Intensivist, agrees with admission, discusses case

V. Case Narrative

PATIENT: 68 year old
CC: "I Passed out"

HPI: *Use lay terminology as the voice of the patient*

*** Case will start with a presentation by EMS: 68 year old running a marathon had a sudden collapse during mile 16. Patient was seen staggering for a hundred yards before he suddenly fell down on the pavement. Patient started dry heaving while on the ground and then had a syncopal episode. Bystanders report patient was unconscious for 5 minutes until paramedics arrived. Patient is confused and agitated. EMS started a peripheral IV and gave 500 CC's bolus of normal saline en route to the hospital:

Per the patient's son, paramedics learn that the patient has a medical history of hypertension and is allergic to penicillin and morphine. Patient has no history of tobacco or drugs.

Patient reports, "I was running in the marathon and collapsed. I was feeling hotter than usual. Then I started vomiting." Patient will then start to say unusual phrases, making incoherent statements but speaking clearly (avoid intubation). For example:

- I was eating..mile 15…paramedic..then went to green…shoes.
- Staying Africa…exam…policeman..the marathon…Rick..finish…line

PMHx:
Hypertension
Appendectomy, age 30

MEDICATIONS	ALLERGIES
Lisinopril	Morphine Penicillin

PSHx: Unknown

SOCIAL Hx:
EtOH: Denies
Tobacco: Denies
Illicits: Denies
Occupation: Retired Lieutenant Colonel
Additional: Widowed

FAMILY Hx:
Son: Cerebral Palsy

ROS:
(+) Diaphoresis, palpitations, muscle weakness, nausea/vomiting

(-) Fever/chills, constipation/diarrhea, blood in stool, hematemesis

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
122	80/60	42.0^o	98%	28

GENERAL: Alert and oriented to person only (unsure of time or place), diaphoretic
HEENT: PERRL/EOMI, CN II-XII intact, flat neck veins
CV: Sinus tachycardia
PULM: CTAB
ABD: Soft, NT/ND, +BS
EXT: No C/C/E, diminished peripheral pulses, no signs of compartment syndrome
NEURO: Does not follow commands, no focal deficit, flexion withdrawal to painful stimuli

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	X
Basic Metabolic Panel	X	Lactate/Cortisol Level	X
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	X
Complete Blood Count (CBC)		Urinalysis	X
CBC with differential	X	Urine HCG	

Additional Labs: **Creatine kinase level**

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast	X	X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
PCP- Dr. Myers: Participants may page the Primary care provider to get background information on the patient, PMH, drugs, social hx, etc. No other clinical assistance will be provided.

Nephrologist- Dr. Jefferson: Participants may page nephrology due to the elevated BUN/creatinine. Recommendation will include aggressive fluid resuscitation, cooling of the patient, and obtaining a creatine kinase (CK) level. Consult will also recommend treating the hyperkalemia and referring patient to ICU. (If the participants ask how to treat hyperkalemia, recommend sodium bicarbonate, calcium chloride or calcium gluconate, and insulin/glucose.)

Intensivist- Dr. Adams: Recommend aggressive IV fluid resuscitation with normal saline and consider sodium bicarbonate therapy. Place a Foley catheter to measure urine output. Follow creatine kinase levels. Spray the patient with water and place a large fan next to him for evaporative cooling.

CLINCAL PROGRESSION:
Patient will be unable to provide an adequate history. Participants will get initial HPI and history from EMS that can be repeated at the onset per the confederate EMT/Paramedic or overhead voice. Participants should start IV/O_2/monitor, begin assessing patient, provide IV fluids, and build a broad differential diagnosis. Students may request a consult from any one of the above consultants. Participants will be advised to continue fluids, cool the patient down, and admit to the ICU. If fluids and cooling measures are initiated the case will end with disposition to the ICU.

If students fail to provide fluids within 10 minutes of start of case, patient vitals will worsen:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
126	70/50	39.0^o	98%	28

VI. Instructor Notes

A. Tips to keep scenario flowing
   1. If students start treating hyperkalemia but have not considered rhabdomyolysis, nurse can provide abnormal CK level to prompt participants for further management
   2. Nurse can highlight abnormal BUN/creatinine to prompt participants to call nephrology

B. Scenario programming
   1. Optimal management path:
      - O_2/IV/monitor
      - History and physical examination
      - Aggressive fluid resuscitation
      - Appropriate lab work-up: BMP, CBC, urinalysis, toxicology screen, lactate level, creatine kinase level, hepatic panel
      - Appropriate imaging: ECG, CXR, head CT
      - Treat hyperkalemia with insulin/glucose and calcium
      - Initiate cooling measures
   2. Potential complications/errors path(s):
      - Failure to provide fluids
   3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
   1. Team dynamics
      i. Leadership
      ii. Collaboration
      iii. Communication
      iv. Professionalism
   2. Didactic material
      i. Presentation
         a. Diversity of presenting complaints from muscle aches to acute renal failure and coma
         b. Broad differential diagnosis (can use a systems approach)
         c. Range of CK levels and timing of peak serum CK concentration

d. Exercise hyperthermia
e. Important metabolic abnormalities in rhabdomyolysis (hyperkalemia, hypocalcemia, hyperphosphatemia, metabolic acidosis)

b. Etiology: exercise, drugs, medications (ACE inhibitor, HCTZ, statins), direct muscle injury, seizure, DKA, infections, heat related syndromes, myopathies
c. Pathophysiology
    i. necrosis of striated muscles
    ii. ARF: major theories (volume depletion resulting in renal ischemia, direct tubular injury)
d. Treatment
    i. IVF resuscitation: volume repletion and to establish a diuresis
    ii. Management/diagnosis of underlying cause
    iii. Serial measurements important (serum potassium, calcium, phosphate, and creatinine, urine pH, urine output
    iv. Discuss indications for dialysis
    v. Discuss theory behind urine alkalinization (although no longer recommended over aggressive IV fluid resuscitation
    vi. Discuss EKG findings/management of hyperkalemia
e. Complications
    i. Cardiac arrest, acute renal failure

VIII. Development and Deployment

This case was developed for independent study sessions for first and second year medical students. Variants have been deployed as part of "transition to the wards" integration curricula for rising third year medical students.

IX. Authors/Contributors

Case drafted by Rami Ahmed, D.O, with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	147	135-147 mmol/L
Potassium	7.0	3.5-5.2 mmol/L
Chloride	110	95-107 mmol/L
CO_2	12	22-30 mmol/L
Urea Nitrogen (BUN)	85	7-20 mg/dL
Creatinine	4.8	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL

CHEMISTRY TESTS		Reference Range
Lactate	2.2	0 – 1.5 mEq/L
Creatine Kinase	21,000	25 – 200 IU/L
HCG	0	0 – 5 IU/L

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	22,000	4,500 - 10,000 K/uL	
Neutrophils (%)	65	54 – 62%	
Band forms (%)	4	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.35	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	24	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	15.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	45.0	41 – 50%	36 – 44%

Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	100,000	100,000 - 450,000 K/uL	

HEPATIC PANEL		Reference Range	
		Age 25-60	Age >61
Albumin	4.0	3.5 – 5.0 g/dL	
Alkaline Phosphatase	220	33 – 131 IU/L	51 – 153 IU/L
Aspartate Aminotransferase (AST)	1000	15-50 IU/L	
Alanine Aminotransferase (ALT)	1200	6-50 IU/L	
T. Bilirubin	0.7	0.1 – 1.2 mg/dL	
D. Bilirubin	0.1	0 – 0.3 mg/dL	
Total Protein	7.4	6.3 – 8.5 g/dL	

SERUM KETONES		Reference Range
Beta Hydroxybutyrate	0.1	0-0.3
Acetoacetate	0.8	0.3-2.0

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	<10	<10
Salicylates	<5	<5
EtOH	0	0
Opiates	Negative	Negative
Cocaine Metabolites	Negative	Negative
Benzodiazepines	Negative	Negative
Cannabis Derivatives	Negative	Negative
Barbiturates	Negative	Negative

Amphetamines	Negative	Negative

URINALYSIS		Reference Range
Color	Tea colored	Pale to dark yellow, amber
pH	7.3	5 – 8
Specific gravity	1.002	1.002 – 1.035
Protein	Positive	Negative/trace
Glucose	Negative	Negative
Ketones	Negative	Negative
Nitrites	Negative	Negative
Bilirubin	Negative	Negative
Blood	Positive	Negative
Leukocyte	Negative	Negative
Urobilinogen	0.3	0.2 – 1.0 Ehr U/L
MICROSCOPIC URINALYSIS		Reference Range
Red blood cell	0.0	0 – 2/HPF
White blood cell	0.0	0 – 2/HPF

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

ECG: Sinus tachycardia with peaked T-waves
http://www.frca.co.uk/images_main/resources/ECG/ECGresource56.jpg

Head CT: Normal
http://www.urmc.rochester.edu/smd/Rad/neuroimages/CThead.jpg

XII. Appendix C: Teaching Materials

Characteristic Myoglobinuria
http://www.maricopaemergencymedicine.com/gallery/CaseImage/16/16_xlarge.jpg

XIII. Appendix D: Interesting articles to discuss/reference

a) Curry, SC, Chang, D, Connor, D. *Drug- and toxin-induced rhabdomyolysis*. Ann Emerg Med 1989; 18:1068.
b) Sinert R, et al: *Exercised-induced rhabdomyolysis*. Ann Emerg Med 1994; 23:1301.
c) Grossman RA, et al: *Nontraumatic rhabdomyolysis and acute renal failure*. N Engl J Med 1974; 291:807.
d) Singhal PC, et al: *Rhabdomyolysis and acute renal failure associated with cocaine abuse*. Clin Toxicol 1990; 28:321.

GASTROINTESTINAL CASES

Gilbert Program in Medical Simulation

Harvard Medical School

Acute Cholecystitis

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Vital signs
☐	Patient history
☐	Physical examination
☐	IV fluid resuscitation
☐	Pain management
☐	Appropriate imaging: abdominal ultrasound and/or CT scan
☐	Appropriate laboratory studies: cbc, chemistry, LFTs, lipase
☐	Initiate antibiotic therapy
☐	Surgical consult

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
C.
   1. Radiologist: reads chest x-ray, ultrasound
   2. Cardiologist: reads ECG
   3. Surgery: recommends treatment plan

V. Case Narrative

PATIENT: 42 year old
CC: RUQ pain

HPI: *Use lay terminology as the voice of the patient*

Patient presents with persistent, sharp, severe RUQ pain for the past five hours. Patient states that s/he started experiencing "indigestion" about an hour after going out for breakfast with friends (ate fried potatoes, an omelet, and buttered toast); symptoms have not abated since that time. Patient has had similar symptoms in the past after eating fatty foods, but this is lasting a little longer than usual. Patient tried taking some antacids, but this didn't help.

PMHx:
GERD
Obesity

MEDICATIONS	ALLERGIES
If female, oral contraceptives Multivitamin Antacids OTC, as needed	NKDA

PSHx:
None

Social Hx:
EtOH: 5 drinks/week
Tobacco: Denies
Illicits: Denies
Occupation: Works as a high school biology teacher
Additional: Divorced and dating currently, 3 children (ages 8, 10, and 12)

FHx:
Father: MI at age 70

ROS:
(+) Slight headache

(-) No fever/chills, nausea, vomiting, infectious exposure, melena or other changes in stools/bowel habits, recent dietary changes, or recent travel,

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature	O_2 Sats (RA)	RR
102	144/86	37.0	99%	18

GENERAL: Uncomfortable-appearing, obese.

HEENT: No abnormalities
NECK: Supple, JVP not elevated
CV: Tachycardia. Regular rhythm. No m/r/g.
PULM: CTAB, with good bilateral air entry
ABD: Non-distended, soft, tender to palpation in RUQ. positive Murphy's sign, normal bowel sounds, no organomegaly or masses. Rectal: guaiac negative brown stool, non-tender.
SKIN: No rashes, warm to touch, cap refill <2 s
EXT: No C/C/E, palpable pulses all extremities
NEURO: MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level	X	Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	X
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	X

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	
CT Scan, with contrast	X	MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	X

Additional Images: none

CONSULTS:
Radiologist – Dr. Smith: Will read CT of the abdomen and/or ultrasound of the abdomen and confirm that the chest x-ray is unremarkable.

Abdominal Ultrasound: This is notable for gallbladder sludge and wall thickening, with pericholecystic fluid.

CT of the abdomen with IV Contrast: This confirms stones in the gallbladder and wall thickening.

GI Surgeon – Dr. Graham: After hearing the diagnosis of cholecystitis, will admit patient for antibiotics, observation—explain that they likely will take the patient to the OR after a few days of antibiotics. Ask students to initiate broad-spectrum antibiotics, manage pain and continue supportive care with fluid therapy.

CLINCAL PROGRESSION:
History and physical, IV access, and monitor. Students must treat pain and determine future management of patient. Case will end when students decide to end emergency department care, either through surgical consult/admission or admission for observation.

***If pain managed appropriately, heart rate and blood pressure improve to normal ranges:

HR	BP	Temperature	O_2 Sats (RA)	RR
92	130/80	37.0	99%	12

VI. Instructor Notes

A. Tips to keep scenario flowing
1. Patient will continue asking for pain medication if not administered.
2. If students are unsure what to do, nurse will prompt surgery consult who will ask for presentation of patient and will recommend abdominal ultrasound.

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor
- History and physical examination
- Appropriate lab work-up: BMP, CBC, hepatic panel, amylase/lipase
- Appropriate imaging: CXR, abdominal U/S
- IV fluid resuscitation
- Manage pain (analgesic)
- Initiate antibiotic therapy
- Recommend for cholecystectomy

2. Potential complications/errors path(s): failure to administer antibiotics or appropriate consultation
3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
1. Team dynamics
   i. Leadership
   ii. Collaboration
   iii. Communication
   iv. Professionalism
2. Didactic material
   i. Presentation
      1. Murphy sign
      2. Systemic symptoms (fever)
   ii. Etiology and Pathophysiology
   iii. Treatment
      1. Decision about antibiotic selection
      2. Decision to admit patient for surgery: biliary colic v. cholecystitis
   iv. Complications
      1. Perforation/rupture
      2. Ascending cholangitis
      3. Surgery complications: bile leak, wound infection, bleeding, etc.

VIII. Development and Deployment

This case was developed as part of an integrated clinical teaching module for second-year medical students, and has been used over several years..

IX. Authors/Contributors

Case drafted by Emily Hayden, M.D. with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. References

a) Strasberg SM. Clinical practice. Acute calculous cholecystitis. N Engl J Med. Jun 26 2008;358(26):2804-11.

XI. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	3.5	3.5-5.2 mmol/L
Chloride	100	95-107 mmol/L
CO_2	24	22-30 mmol/L
Urea Nitrogen (BUN)	20	7-20 mg/dL
Creatinine	1.2	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL

CHEMISTRY TESTS		Reference Range
Lipase	34	7 – 60 IU/L
Urine HCG	Negative	N/A

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	16,000	4,500 - 10,000 K/uL	
Neutrophils (%)	65	54 – 62%	
Band forms (%)	8	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	10	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	13.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.2	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	400,000	100,000 - 450,000 K/uL	

HEPATIC PANEL		Reference Range	
		Age 25-60	Age >61
Alkaline Phosphatase	285	33 – 131 IU/L	51 – 153 IU/L
Aspartate Aminotransferase (AST)	35	15-50 IU/L	
Alanine Aminotransferase (ALT)	25	6-50 IU/L	
T. Bilirubin	0.3	0.1 – 1.2 mg/dL	
D. Bilirubin	0.1	0 – 0.3 mg/dL	
Total Protein	7.3	6.3 – 8.5 g/dL	

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.med.yale.edu/intmed/cardio/imaging/findings/normal_chest_pa2/index.html

Abdominal Ultrasound: Gallstones in neck causing acoustic shadowing, with gall bladder wall thickening >4mm: http://emedicine.medscape.com/article/774352-media

Abdominal CT: http://www.aic.cuhk.edu.hk/web8/Hi res/Cholecystitis.jpg

Lower Gastrointestinal Bleeding

I. Target Audience: Medical students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Order laboratory studies: cbc, chemistries, coagulation studies, lactate
☐	Aggressive IV fluid resuscitation
☐	Stool guaiac
☐	Type and cross/Type and screen
☐	GI consultation

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   4. IV line
   5. Lab values
   6. Images
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants: Gastroenterologist - recommends treatment plan

V. Case Narrative

PATIENT: 45 year-old

CC: Diarrhea and rectal bleeding

HPI: *Use lay terminology as the voice of the patient*

Ms./Mr. Jones is a 45-year-old African American (wo)man who presents with diarrhea and rectal bleeding. Patient was in her usual state of good health until one day ago when patient developed some crampy lower abdominal pain and loose stools. The pain is associated with bowel movements, and improves after passing stool. The pain does not radiate, and is 4-5/10 in intensity.

Patient had 8-9 bowel movements yesterday, and then overnight had several more loose bowel movements that were mainly red blood with a small amount of liquid stool. Patient stated that the blood seemed to fill the toilet bowl, and that it caused a lot anxiety as patient has never had that much rectal bleeding before. Patient has hemorrhoids and has had intermittent bleeding in the past, but never as much as in the past 24 hours. Patient has not had any fevers, but did have some nausea without any vomiting. Patient also states that his/her bowel movements have decreased in frequency over the past several hours, with last bowel movement being five hours prior.

PMHx:
Hypertension
Depression

MEDICATIONS	ALLERGIES
Multivitamin daily Aspirin 81 mg daily Hydrochlorothiazde 12.5 mg daily	Penicillin

SOCIAL Hx:

EtOH:	3-4 drinks/week
Tobacco:	Denies
Illicits:	Denies
Occupation:	Lawyer
Additional:	Married, lives with spouse and two children, does not take any herbal medications or other over-the-counter medications.

FAMILY Hx:

Father:	MI, age 67
Mother:	Colon cancer diagnosis, age 49
Sister:	Healthy
Brother:	Prostate cancer

No family history of inflammatory bowel disease

ROS:
(+) Diarrhea, slight nausea, rectal bleeding, abdominal pain, orthostasis

(-) No melena, vomiting, fever/chills, abdominal distention, headache, dysuria, hematuria, weight loss, rashes, joint pains, headaches, vision changes, shortness of breath, cough, or chest pain.

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
108	122/82	37.4^o	100%	16

GENERAL: Alert. Appears anxious, pale, and diaphoretic, but not in any acute distress
HEENT: Anicteric sclera. Pale conjunctiva. Supple neck. Dry mucosal membranes. No cervical or supraclavicular lymphadenopathy
PULM: CTAB, no dullness to percussion
CV: Regular tachycardia. No murmurs
ABD: Soft, non-distended, very mild tenderness on the left lower quadrants on deep palpation. No inguinal or femoral hernias. No masses. No HSM
EXT: No peripheral edema
RECTAL: No external hemorrhoids, no internal masses, non-tender, no stool in the rectal vault, but gross blood on glove
SKIN: No rashes and no jaundice.
NEURO: Grossly normal.

LABS: See Appendix A

Amylase/Lipase Level	X	Comprehensive Metabolic Panel	
Arterial Blood Gas		Lactate/Cortisol Level	X
Basic Metabolic Panel	X	Hepatic Panel	X
Cardiac Markers		Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	X
CBC with differential	X	Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	
Echocardiogram		Ultrasound	

Additional Images: Endoscopy

CONSULTS:
Gastroenterologist – Dr. Cole: Consult may advise participants to provide IV fluids if they fail to do so.

CLINICAL PROGRESSION:
History and physical, IV/O2/monitor. Students are expected to recognize possible GI bleeding, consult GI, order 2 large bore IVs, type and cross for blood transfusion. Once students consult GI and discuss future management, case will end.

***If the students give 1-2 liters of fluid or blood products within the first 10-15 minutes of the case:

HR	BP	Temperature	O_2 Sats (RA)	RR
100	122/82	37.4	100%	16

***If fail to give fluids within 15 minutes of the start of the case, vitals will worsen with blood pressure gradually dropping and a slight increase in heart rate. If deemed necessary, GI or Primary care provider will call for guidance:

HR	BP	Temperature	O_2 Sats (RA)	RR
115	90/52	37.4	100%	16

VI. Instructors Notes

A. Tips to keep scenario flowing
1. If IV fluids are not provided, instructor can verbalize need to stabilize as patient becomes increasingly hypotensive in order to prompt supportive care.
2. If student are unsure of imaging modality to confirm diagnosis, GI consult will recommend endoscopy

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor
- History and physical examination
- Aggressive fluid resuscitation WITH 2 large bore IVs
- Appropriate lab workup
  - Include type and cross OR type and screen depending upon suspected blood loss
  - Hct
  - Coagulation panel
- Transfusion
- Plan for colonoscopy
- Consider need for antibiotic therapy
- Consult specialist for definitive care/determine need for surgical intervention
- Transfer to OR for laparotomy, if required

2. Potential complications/errors path(s):
- Failure to administer fluids
- Failure to recognize need for specialist/surgical intervention

3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
1. Team dynamics
   i. Leadership

ii. Collaboration
iii. Communication
iv. Professionalism

2. Didactic material

a. Appropriate differential diagnosis of lower GIB
    i. Broad differential diagnosis: anatomic (diverticulosis); vascular (angiodysplasia, ischemic, radiation-induced); inflammatory (infectious, idiopathic); neoplastic
b. Pathophysiology of diverticular bleed
c. Workup/Treatment options
    i. Discuss why endoscopy and colonoscopy are both warranted when searching for source of GIB
    ii. Discuss definitive way to determine origin of GIB
    iii. Other studies (radionuclide imaging, angiography)
    iv. Appropriate disposition – ICU vs floor, Surgical consultation (Hemodynamic instability, active bleeding..)
d. Colon cancer
    i. Familial history
    ii. Surveillance

VIII. Development and Deployment

This case was developed as part of an elective GI pathophysiology module for second year medical students; the module combines cognitive and procedural (GI endoscopy) simulation, and has been deployed as a recurrent offering.

IX. Authors/Contributors

Case drafted by Steven Kappler, M.D. with Emily Hayden, M.D. and Helen Shields, M.D.; additional contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	3.5	3.5-5.2 mmol/L
Chloride	100	95-107 mmol/L
CO_2	24	22-30 mmol/L
Urea Nitrogen (BUN)	25	7-20 mg/dL
Creatinine	1.0	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL

CHEMISTRY TESTS		Reference Range
Amylase	136	53 – 123 IU/L
Lipase	3.5	7 – 60 IU/L
Lactate	2.4	4.5 – 19.4 mg/dL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	40	30 – 45 sec
Prothrombin time (PT)	12	10 – 12 sec
International Normalized Ratio (INR)	1	1 - 2

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	10,000	4,500 - 10,000 K/uL	
Neutrophils (%)	59	54 – 62%	
Band forms (%)	4	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.35	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	8.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	24.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	250,000	100,000 - 450,000 K/uL	

HEPATIC PANEL		Reference Range	
		Age 25-60	Age >61
Albumin	4.0	3.5 – 5.0 g/dL	
Alkaline Phosphatase	70	33 – 131 IU/L	51 – 153 IU/L
Aspartate Aminotransferase (AST)	35	15-50 IU/L	
Alanine Aminotransferase (ALT)	23	6-50 IU/L	
T. Bilirubin	0.5	0.1 – 1.2 mg/dL	
D. Bilirubin	0.2	0 – 0.3 mg/dL	
Total Protein	6.8	6.3 – 8.5 g/dL	

URINALYSIS		Reference Range
Color	Tea colored	Pale to dark yellow, amber
pH	7.3	5 – 8
Specific gravity	1.002	1.002 – 1.035
Protein	Negative	Negative/trace
Glucose	Negative	Negative
Ketones	Negative	Negative
Nitrites	Negative	Negative
Bilirubin	Negative	Negative
Blood	Negative	Negative
Leukocyte	Negative	Negative
Urobilinogen	0.3	0.2 – 1.0 Ehr U/L
MICROSCOPIC URINALYSIS		Reference Range
Red blood cell	7.0	0 – 2/HPF
White blood cell	0.0	0 – 2/HPF

XI. Appendix B: Teaching Materials

http://www.nygastrodoctor.com/id1.html

XII. Appendix C: Interesting articles to discuss/reference

a) Zuccaro, G. *Management of the adult patient with acute lower gastrointestinal bleeding*. Am J Gastroenterol 1998; 93:1202.

b) Lim J, Ahmed A. *Endoscopic Approach to the Treatment of Gastrointestinal Bleeding*. Techniques in Vascular and Interventional Radiology 2004; 7(3):123-129.

c) Davila, RE, Rajan, E, Adler, DG, et al. ASGE *Guideline: the role of endoscopy in the patient with lower-GI bleeding*. Gastrointest Endosc 2005; 62:656.

d) Witting M, et al. *Usefulness and Validity of Diagnostic Nasogastric Aspiration in Patients without Hematemesis* Annals of Emergency Medicine 2004; 43: 525-532.

e) Olds, GD, Cooper, GS, Chak, A, et al. *The yield of bleeding scans in acute lower gastrointestinal hemorrhage*. J Clin Gastroenterol 2005; 39:273.

Upper Gastrointestinal Bleed

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Make patient NPO
☐	Aggressive IV fluid resuscitation
☐	Obtain laboratory studies: cbc, chemistries, coagulation studies, lactate
☐	Consult GI for endoscopy
☐	Administer IV proton pump inhibitor

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. IV line
   2. Lab values
   3. Images
   4. PRBC
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants*(optional for higher level residents who can provide interpretation on their own)*
   1. Gastroenterologist, recommends treatment plan
   2. Radiologist, interprets images

V. Case Narrative

PATIENT: 54 year old
CC: Vomiting blood

HPI: *Use lay terminology as the voice of the patient*

Patient reports multiple episodes of vomiting and mild epigastric pain beginning this morning. Emesis was initially coffee-ground, now becoming bright red with some clots. Recent burning epigastric pain, not relieved by Maalox.

PMHx:
Recent admission for r/o MI: Normal exercise treadmill stress EKG at that time
Hypertension
Hypercholesterolemia
Arthritis

MEDICATIONS	ALLERGIES
Ibuprofen ~600 mg BID x 1 year (knee pain, bilaterally) HCTZ Simvastatin Metoprolol	NKDA

PSHx: Appendectomy,age 19

SOCIAL Hx:
EtOH: History of heavy abuse
Tobacco: Quit 2 years ago after heavy use
Illicits: Denies
Occupation: Line cook
Additional: Divorced

FAMILY Hx: No h/o cardiac diseases or ulcers that the patient is aware of

ROS:
(+) Abdominal pain, nausea, melena, orthostasis

(-) No headache, fevers/chills, constipation/diarrhea, diaphoresis, shortness of breath

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^{o}C)	O_2 Sats (RA)	RR
140	95/60	37.0	99%	16

GENERAL: Pale, AAOX3
HEENT: Pale conjunctiva, non-icteric sclera
PULM: CTAB

CV: Tachycardic but regular, no murmurs/gallops
ABD: Soft, mild mid-epigastric TTP, no masses/organomegaly
RECTAL: Guaiac positive black stool
EXT: No c/c/e

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	X
Complete Blood Count (CBC)	X	Urinalysis	X
CBC with differential		Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: Esophagogastroduodenoscopy

CONSULTS:
Gastroenterologist – Dr. Cole: recommends endoscopy, IV PPI, NG lavage

CLINICAL PROGRESSION:
History and physical, adequate IV access, IV fluids, and monitor. Students are expected to recognize GI bleeding, consider NG lavage (if they do lavage, coffee grounds are present, no gross blood), order appropriate laboratory studies, consult GI and determine need for blood products. Students may administer acid suppressors (proton pump inhibitors). Once students consult GI and discuss future management, case will end. *Patients can require more aggressive fluid resuscitation, and scenario may include increasing emesis with intubation for airway protection if time allows.*

***If the students give 1-2 liters of fluid or blood products within the first 10 minutes of the case:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
110	145/90	37.0^o	99%	16

***Failure to give fluids within 10 minutes of the start of the case OR failure to consider GI bleeding as part of differential diagnosis, vitals will worsen with blood pressure gradually dropping and a slight increase in heart rate. *If deemed necessary*, GI or Primary care provider will call for guidance.

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
150	70/40,	37.0^o	99%	16

VI. Instructors Notes

A. Tips to keep scenario flowing

B. If students fail to properly resuscitate patient, prompting can come in form of a primary care physician calling to check in on their patient.

1. If IV fluids are not provided, patient becomes increasingly hypotensive as case progresses.
2. If student are unsure of imaging modality, gastroenterology will recommend upper endoscopy

C. Scenario programming

1. Optimal management path:
    - O_2/IV/monitor
    - History and physical examination
    - Aggressive fluid resuscitation
    - Appropriate lab workup
        - Include type and cross OR type and screen depending upon suspected blood loss
        - Include rule-out MI
        - Include HCT, coagulation panel
    - Order endoscopy (esophagogastroduodenoscopy)
    - Administer proton pump inhibitor
    - Consult specialist for definitive care/determine need for surgical intervention
    - Transfer to OR for laparotomy, if required
2. Potential complications/errors path(s):
    - Failure to administer fluids
    - If pertinent, failure to recognize need for surgical intervention
3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials

B. Potential Debriefing topics

a. Appropriate differential diagnosis
    i. Discuss definitive way to determine origin of GIB
    ii. Discuss why endoscopy and colonoscopy are both warranted when searching for source of GIB

b. Management of gastrointestinal bleed
    i. ABC's
    ii. resuscitation with IVFs and blood products if necessary
    iii. appropriate laboratory studies
    iv. IV PPI
    v. octreotide

c. Etiology
    i. NSAIDs, H Pylori, alcohol, and acid contributes to ulcers

VIII. Development and Deployment

This case was developed as part of an elective GI pathophysiology module for second-year medical students; the module combines cognitive and procedural (GI endoscopy) simulation, and has been deployed as a recurrent offering

IX. Authors/Contributors

Case adapted by Emily Hayden, M.D. with Steven Kappler, M.D. and Helen Shields, M.D. based on case material by Shaffer, Shields and Upton (reference below), with contributions and updates by the Gilbert Simulation Team. Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. References

a) Adler DG, Leighton JA, Davila RE, Hirota WK, Jacobson BC, Quereshi WA, Rajan E, Zuckerman MJ, Fanelli RD, Hambrick RD, Baron T, Faigel DO. ASGE guideline: the role of endoscopy in acute non-variceal upper-GI hemorrhage. Gastrointest Endosc 2004 Oct;60(4):497-504.

b) Lau, et al. Omeprazole before endoscopy in patients with gastrointestinal bleeding. N Engl J Med. 2007 Apr 19;356(16):1631-40.

c) Romagnuolo, J, et al. Simple clinical predictors may obviate urgent endoscopy in selected patients with nonvariceal upper gastrointestinal tract bleeding. *Arch Intern Med*. 2007; 167(3):265-70.

d) Shaffer K, Shields H, Upton M. "Chest Pain and Anemia in a Middle-Aged Man: A Mystery in Five Acts," A case for the Gastrointestinal Pathophysiology Website, Harvard Medical School.

XI. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	3.5	3.5-5.2 mmol/L
Chloride	100	95-107 mmol/L
CO_2	24	22-30 mmol/L
Urea Nitrogen (BUN)	40	7-20 mg/dL
Creatinine	1.2	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL

CARDIAC MARKERS		Reference Range
Creatine Kinase-BB	0%	0%
Creatine Kinase-MB (cardiac)	0%	0 - 3.9%
Creatine Kinase-MM	100%	96 – 100%
Creatine phosphokinase (CPK)	85	8 – 150 IU/L
Troponin I	< 0.03	< 0.03 ng/mL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	41	30 – 45 sec
Prothrombin time (PT)	10	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 - 2

COMPLETE BLOOD COUNT		Reference Range	
		Male	Female
White Blood Cell (WBC)	10,000	4,500 - 10,000 K/uL	
Hemoglobin (HGB)	9	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	27	41 – 50%	36 – 44%
Platelet	150,000	100,000 - 450,000 K/uL	

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	0	<10
Salicylates	0	<5
EtOH	0	0
Opiates	Negative	Negative
Cocaine Metabolites	Negative	Negative
Benzodiazepines	Negative	Negative
Cannabis Derivatives	Negative	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
Male: http://www.yale.edu/imaging/findings/normal_heart/index.html
Female: http://www.rctradiology.com/icons/normalchest.jpg

ECG: Sinus tachycardia
http://www.emedu.org/ecg/images/st_1a.jpg

NEUROLOGICAL CASES

Gilbert Program in Medical Simulation

Harvard Medical School

Migraine

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Vital signs
☐	Patient history
☐	Physical examination, including complete neurologic exam
☐	Analgesia

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads head CT

V. Case Narrative

PATIENT: 29 year old
CC: Headache

HPI: *Use lay terminology as the voice of the patient*

Patient presents with a throbbing left-sided headache that began gradually in the morning. This is similar to past headaches the patient has had, though somewhat more severe. Pain is localized behind left eye and started "out of the blue" this morning as patient woke up about 5 hours prior to arrival at emergency department. Headache intensified when patient got up to use the bathroom this morning. Patient tried Tylenol with no relief and is now starting to feel as though his/her vision may be getting a little blurry on the left side where it really hurts.

Patient is scared that this is a stroke and doesn't want to move his head because any movement makes the pain worse. Patient reports some slight nausea and felt the need to vomit earlier but has not yet. Patient feels a little dizzy and some possible numbness around the lips, mostly on the left side.

Patient has not eaten anything since last night where s/he reports partying a little more than usual, but nothing really out of the ordinary, "had a glass of red wine and a few beers, came home and went to bed." Patent reports smoking a few cigarettes although typically not a smoker unless at a party and typically doesn't drink wine.

PMHx: Denies

MEDICATIONS	ALLERGIES
Ibuprofen, as needed	NKDA

PSHx:
Appendectomy, age 16
Tonsilectomy, age 8

SOCIAL Hx:
EtOH: Socially
Tobacco: Occasionally
Illicits: Denies
Occupation: Architect
Additional: Dating, lives alone and has two healthy brothers

FAMILY Hx:
Father: "May have had a stroke when he was in his 60s"
Mother: Hypertension, migraines

ROS:
(+) Headache, photophobia, phonophobia, blurry vision on left side, nausea, lightheadedness/dizziness

(-) No focal weakness, fever/chills, weight loss, night sweats, diarrhea/constipation, chest pain, palpitations, abdominal pain, sick contacts or recent travel

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
105	120/60	37.5^o	98%	14

GENERAL: Uncomfortable appearing, pale
HEENT: No post-nasal drip, no maxillary/sinus tenderness
No retinal hemorrhage, disc margins sharp, PERRLA, EOMI, visual acuity grossly intact
NECK: Supple, no meningismus
PULM: CTAB
CV: Regular rate and rhythm
ABD: Soft, NT/ND
EXT: WNL
NEURO: CN II-XII intact, motor strength 5/5 bilateral upper and lower extremities, normal sensation to light touch, patient refuses to ambulate
Negative Kernig's (extend knee when hip flexed 90^o)
Negative Burdzinski's (flex hips with passive flexion of the neck)

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	X
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	

Additional Labs: +/- lumbar puncture

IMAGES: See Appendix B

Angiogram		ECG	
CT Scan, with contrast		MRI	
CT Scan, without contrast	X	X-Ray	
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Radiology – Dr. Smith: Reads CT head as negative, *if needed*

CLINICAL PROGRESSION:

History and physical, O_2/IV/monitor. Students must treat pain and determine future management of patient. Case will end when students release patient, educating patient about possible triggers, how to recognize signs of aura, and need for abortive medication.

***If NSAID, anti-emetic (prochlorperazine, metoclopramide), or triptan given (oral, IM, IV), headache improves, pain gradually reaches rating of 5 (1-10 scale)

VI. Instructor Notes

A. Tips to keep scenario flowing
   1. Patients asks "Doc, aren't you going to give me something for my head?"
   2. Nurse suggests analgesics, as necessary.

B. Scenario programming
   1. Optimal management path:
      - O_2/IV/monitor
      - History and physical examination
      - Analgesia
   2. Potential complications/errors path(s): N/A
   3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential Debriefing topics
   1. Team dynamics
      a. Leadership
      b. Collaboration
      c. Communication
      d. Professionalism
   2. Didactic material
      i. Aura vs. no aura
      ii. Systemic manifestations (nausea, vomiting, scotoma, paresthesias, photophobia)
      iii. Historical factors suggesting a more serious underlying cause of headache
      iv. Indications for imaging: unexplained neurological finding, atypical features, additional risk factor (e.g. HIV), sudden severe headache
      v. Migraine types: basilar type, menstrual, familial hemiplegic, etc.
      vi. Differential diagnosis: migraine, ruptured aneurysm, meningitis, "hangover," brain tumor, opportunistic infection, drug-induced cerebral vasospasm, stroke
      b. Etiology
         i. Triggers: list of foods, environmental, etc.
      c. Pathophysiology
      d. Treatment
         i. Mechanism of Toradol
         ii. Mechanism of Triptan

iii. Mechanism of antiemetics
iv. Abortive medications
v. Teaching patient to recognize signs of aura

VIII. Development and Deployment

This case was developed for independent study sessions for first and second year medical students, and also used as a teaching module for third year clerkship students.

IX. Authors/Contributions

Case drafted by Kimberly Khoury, M.D., with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Reference

a) Edlow, J, et al. Clinical Policy: Critical Issues in the Evaluation and Management of Adult Patients Presenting to the Emergency Department With Acute Headache. Ann Emerg Med. 2008;52:407-436.

b) Headache classification subcommittee of the International Headache Society. *The International Classification of Headache Disorders: 2nd edition*. Cephalalgia 2004; 24 Suppl 1:9.

c) Griffith JD, Mycyk MB, & Kyriacou DN. *Metoclopramide Versus Hydromorphone for the Emergency Department Treatment of Migraine Headache*. Journal of Pain, 2008. Vol 9 (1): p. 88 – 94.

d) Coppola M, Yealy DM, & Leibold RA. *Randomized, Placebo-Controlled Evaluation of Prochlorperazine Versus Metoclopramide for Emergency Department Treatment of Migraine Headache*. Annals of Emegency Medicine, Nov 1995. 26 (5): p. 541 – 546.

e) Colman, I, Friedman, BW, Brown, MD, et al. *Parenteral dexamethasone for acute severe migraine headache: meta-analysis of randomised controlled trials for preventing recurrence*. BMJ 2008; 336:1359.

XI. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	4.2	3.5-5.2 mmol/L
Chloride	102	95-107 mmol/L
CO_2	246	22-30 mmol/L
Urea Nitrogen (BUN)	10	7-20 mg/dL
Creatinine	1.0	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	41	30 – 45 sec
Prothrombin time (PT)	10	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 - 2
Fibrinogen	200	170 – 420 mg/dL

COMPLETE BLOOD COUNT		Reference Range	
		Male	Female
White Blood Cell (WBC)	10,000	4,500 - 10,000 K/uL	
Hemoglobin (HGB)	10	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	40	41 – 50%	36 – 44%
Platelet	150,000	100,000 - 450,000 K/uL	

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	0	<10
Salicylates	0	<5
EtOH	0	0
Opiates	Negative	Negative
Cocaine Metabolites	Negative	Negative
Benzodiazepines	Negative	Negative
Cannabis Derivatives	Negative	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

XII. Appendix B: Diagnostic Studies

Head CT: Negative
http://www.urmc.rochester.edu/smd/Rad/neuroimages/CThead.jpg

TOXICOLOGY CASES

Gilbert Program in Medical Simulation

Harvard Medical School

Cocaine Intoxication

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Immediate ECG and portable CXR (within 10 mins of start of case)
☐	Obtain laboratory studies: cbc, chemistry, troponin, tox screen, coags
☐	Administer immediate aspirin
☐	Administer nitroglycerin and/or morphine
☐	Administer benzodiazepine
☐	Admit patient or transfer patient to observation unit

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG, recommends treatment plan

V. Case Narrative

PATIENT: 27 year old
CC: Chest pain

HPI: *Use lay terminology as the voice of the patient*

Patient complains of substernal chest pain with associated marked diaphoresis, anxiety, and shortness of breath. Symptoms began that evening at a dance club where patient had consumed large amounts of alcohol. Patient reluctantly admits that the chest pain began within minutes of snorting cocaine. Patient denies fever, chills, and vomiting.

PMHx:
Seizures: Cocaine associated, hospitalized
MVC: Alcohol related car accident, ED visit

MEDICATIONS	ALLERGIES
Denies	NKDA

PSHx: Denies

SOCIAL Hx:
EtOH: Daily, ~3/day
Tobacco: ½ pack/day
Illicits: Previous IVDA (heroin), occasional cocaine use (snorted)
Occupation: Struggling actor
Additional: Single, lives with 4 roommates

FAMILY Hx:
Father: Hypertension

ROS:
(+) Chest pain, diaphoresis, shortness of breath

(-) Negative for palpitations, fever, chills, vomiting, headache, blurred vision, numbness/motor weakness, abdominal pain, diarrhea/constipation, and urinary symptoms

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature	O_2 Sats (RA)	RR
120	180/90	38.0	98%	22

GENERAL: A&Ox3, anxious, pressured speech, diaphoretic, aggressive and/or suicidal
HEENT: Unremarkable, dilated pupils *(with possible nasal septal necrosis)*
NECK: Supple, no JVD
PULM: CTAB
CV: Tachycardia

ABD: Soft, NT/ND, + BS
EXT: No C/C/E, palpable pulses all extremities
NEURO: MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	X
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel		Lactate/Cortisol Level	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	X
Complete Blood Count (CBC)	X	Urinalysis	
CBC with differential		Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiology – Dr. Jones: ECG will be read as nonspecific but upon hearing positive cocaine levels in patient, indicate that the patient needs to be stabilized, and that benzodiazepines should be used for the patient's high blood pressure.

Radiology – Dr. Smith: CXR will be read as normal x-ray.

CLINICAL PROGRESSION:
History and physical, IV/O_2/monitor, and immediate aspirin should be administered. Participants should order stat portable CXR, ECG, and laboratory studies. Pharmacologic treatment should first line include benzodiazepine (e.g. Ativan), then consider nitroglycerin, morphine and/or Ca-channel blocker, to improve symptoms. Participants must admit patient or send to observation unit for serial enzymes and ECGs.

***If B-blockers given, increase blood pressure and heart rate as patient complains of worsening symptoms:

HR	BP	Temperature	O_2 Sats (RA)	RR
140	198/100	38.0	98%	24

***If benzo given, patient feels better as blood pressure and heart rate decrease:

HR	BP	Temperature	O_2 Sats (RA)	RR
100	144/80	37.8	98%	22

- If Ca-channel blocker administered along with nitroglycerin, morphine and benzodiazepine, further decrease blood pressure and heart to normal range

VI. Instructor Notes

A. Tips to keep scenario flowing
1. If participants are unsure of medication names but request to lower heart rate with an "anti sympathetic" drug, follow the benzodiazepine response and leave discussions of complications due to B-block for debrief
2. If participants are unsure of pathology, instructor can prompt a cardiology consultation to lead participants in direction of care

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor
- History and physical examination
- Aggressive IV fluid resuscitation with 2 large bore IVs
- Immediate aspirin
- Appropriate lab workup: CBC, CMP, cardiac markers, coagulation profile, toxicology screen
- Appropriate imaging: stat portable CXR, ECG within 10 minutes
- Administer Ca-channel blocker, benzodiazepine, nitroglycerin, morphine
- Determine need to admit patient
- Consult cardiology or observation unit for further treatment

2. Potential complications/errors path(s):
- Failure to administer medication to combat sympathomimetic reaction
- Administering B-blocker medication

3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
1. Team dynamics
   a. Leadership
   b. Collaboration
   c. Communication
   d. Professionalism
2. Didactic material
   a. Pathophysiology
      i. Reinforce/review the function of the sympathetic system
      ii. Discuss action of agonism at alpha and beta 1 and 2 function
      iii. Discuss direct (Beta agonist) vs. indirect (causing release of endogenous catecholamines) effects of sympathomeimetic agents
      iv. Differential is broad in cocaine chest pain: cardiomyopathy, myocarditis, ACS, dissection, pneumomediastinum or pneumothorax
      v. Cocaine + ethanol= increased vasospasm due to cocaethylene
   b. Treatment
      i. Contraindication of Beta antagonism in sympathomimetic overdose
         1. Discuss increase in blood pressure due to unopposed alpha and b2 antagonism

ii. Benzos decrease adrenergic state and provide anxiolysis
iii. Nitrates equally effective, may help with vasospasm
iv. CCB is a coronary artery vasodilator and decreases afterload

c. Complications
i. Myocardial infarction, accelerated atherosclerosis
ii. Possibility of rhabdomyolysis with hyperkalemia

VIII. Development and Deployment

This case was developed for a widely subscribed fourth year medical school elective (emergency medicine/transition to internship), and has been used in this course over several years as part of an instructional toxicology module. It has also been adapted for use as part of a graduate-level science course (college, PhD students).

IX. Authors/Contibutors

Case drafted by Tania Fatovich, M.D., and revised with Emily Hayden, M.D., and Nancy Oriol, M.D.
Additional contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. References

a) Hollander JE. The management of cocaine-associated myocardial ischemia. *N Engl J Med*. Nov 1995; 333(19):1267-72.
b) Rose JS. Cocaethylene: a current understanding of the active metabolite of cocaine and ethanol. *Am J Emerg Med*. Jul 1994; 12(4):489-90.
c) Weber JE, Shofer FS, Larkin GL, Kalaria AS, Hollander JE. Validation of a Brief Observation Period for Patients with Cocaine-Associated Chest Pain. *N Engl J Med.* 2003; 348(6): 510-517.

XI. Appendix A: Lab Values

COMPREHENSIVE METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	3.5	3.5-5.2 mmol/L
Chloride	100	95-107 mmol/L
CO_2	24	22-30 mmol/L
Urea Nitrogen (BUN)	20	7-20 mg/dL
Creatinine	1.2	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL
Calcium	9.3	8.7 - 10.7 mg/d
Total Protein	7.0	6.3 – 8.5 g/dL
Albumin	3.4	3.2 – 5 g/dL
Bilirubin, total	1.0	0.1 – 1.2 mg/dL
Alkaline Phosphatase	70	30 - 125 units/L
Aspartate Aminotransferase (AST)	28	15 – 50 IU/L
Alanine Aminotransferase (ALT)	25	6 – 50 IU/L

CARDIAC MARKERS		Reference Range
Creatine Kinase-BB	0%	0%
Creatine Kinase-MB (cardiac)	2%	0 - 3.9%
Creatine Kinase-MM	98%	96 – 100%
Creatine phosphokinase (CPK)	145	8 – 150 IU/L
Troponin I	0.02	$\leq$ 0.03 ng/mL

COAGULATION PROFILE		Reference Range
Partial thromboplastin time (PTT)	35	30 – 45 sec
Prothrombin time (PT)	12	10 – 12 sec
International Normalized Ratio (INR)	1.0	1 - 2
Fibrinogen	180	170 – 420 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	10,700	4,500 - 10,000 K/uL	
Neutrophils (%)	57	54 – 62%	
Band forms (%)	3	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	15.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	92	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	34	31 – 37 g/dL	
Platelet	320,000	100,000 - 450,000 K/uL	

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	<10	<10
Salicylates	<5	<5
EtOH	Positive	0
Opiates	Negative	Negative
Cocaine Metabolites	Positive	Negative
Benzodiazepines	Negative	Negative
Cannabis Derivatives	Negative	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

EKG: Nonspecific STTW changes
http://bestpractice.bmj.com/best-practice/images/bp/139-3_default.jpg

Ecstasy Intoxication: MDMA-Induced Seizure

I. Target Audience - Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	Active cooling
☐	Labs: Fingerstick, CBC, CMP, UA, Toxicology Screen: Urine/Serum, Cardiac Markers, Coagulation Profile
☐	Imaging: CXR, ECG
☐	Treat agitation/hypertension with benzodiazepines
☐	Administer charcoal for GI decontamination, ONLY to be performed if < 1 hour has elapsed, patient is NOT sedated and intubated

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage necessary
   3. Lines needed
C. Props:
   1. IV line
   2. Supplemental O_2 equipment
   3. Lab values
   4. Images
D. Distracters: Friend of patient may be used as source of background distraction during scenario. Level of distraction at the discretion of instructor (less distractions for novice learners).

IV. Actors

A. Nurse: facilitate scenario
B. Consultants: Poison control/ Toxicology recommends treatment plan
C. Friend: distracts participants from patient care, able to provide initial history

V. Case Narrative

PATIENT: 19 year old
CC: Found "passed out" at a rave

HPI: *Use lay terminology as the voice of the patient*

Patient found down by a friend at a rave. Per the patient's friend, who spoke to EMS, they had been partying since about 5 pm, but friend wouldn't give any info as to exactly what they did except "drink a few beers." Called 911, and when EMS arrived, patient was "having jerking movements of his arms and legs and looked a little blue."

Vitals on scene:

HR	BP	Temperature	O_2 Sats (RA)	RR
120	150/95	37.5	88%	22

***Per EMS*: Patient was unresponsive. They started O_2 and gave him 1 mg of Ativan, came to ED. Jerking movements resolved en route. Fingerstick: 100

PMHx:

MEDICATIONS	ALLERGIES
Denies	NKDA

PSHx:
Appendectomy, age 14

Social Hx:
EtOH: Occasional
Tobacco: Denies
Illicits: Denies
Occupation: Unknown
Additional: *per friend*, "parties occasionally." Will not admit to more than ETOH use.

FAMILY Hx:
Brother: *per friend*, heroin addict, in and out of rehab

ROS:
Unable to elicit from patient

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature	O_2 Sats (RA)	RR
115	150/95	39.0	96%	20

GENERAL: Confused and combative, anxious, speech is pressured.
HEENT: Pupils dilated but reactive. Fuduscopy: No retinal hemorrhage
NECK: Supple, no LAD
NEURO: Non-focal, but unable to cooperate with neurologic exam.

CV: Regular, tachycardic
PULM: CTAB
ABD: Soft, Non-tender, non-distended, no mass/HSM
Reflexes: Strength normal other than as noted above.

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	X
Arterial Blood Gas		Lactate/Corisol Level	
Basic Metabolic Panel		Liver Function Test	
Cardiac Markers	X	Thyroid Panel	
Coagulation Profile	X	Toxicology Screen	X
Complete Blood Count (CBC)	X	Urinalysis	X
CBC with differential		Urine HCG	

Additional Labs: serum toxicology screen

**Note: MDMA screen avoided due to high false negative rate. Management directed at clinical status.

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Toxicologist – Dr. Frank: Will recommend any tests and imaging forgotten in lab workup and will advise treating for MDMA intoxication with active cooling measures, supplemental O_2 and benzodiazepines. Will recommend monitoring sodium level and continuously evaluating effect of management plan.

CLINICAL PROGRESSION:
Obtain history from both patient and friend, perform physical exam, minimize stimuli, administer supplemental O_2 and cool patient.

***If benzodiazepines are administered, blood pressure will gradually decrease and patient will become less agitated

HR	BP	Temperature	O_2 Sats (RA)	RR
105	130/90	38.5	96%	16

***If haldol administered, interference with heat dissipation and lowered seizure threshold may result in increased temperature and small seizure

HR	BP	Temperature	O_2 Sats (RA)	RR
130	150/95	40.5	92%	24

VI. Instructors Notes

A. Tips to keep scenario flowing

B. Scenario programming

1. Optimal management path:
   - O_2/IV/monitor
   - History and physical examination
   - Aggressive fluid resuscitation, benzos, cooling
   - Appropriate laboratory studies and images obtained
2. Potential complications/errors path(s):
   - Failure to initiate cooling, appropriate benzos/IVF
   - Administering large dose of B-blocker, Haldol

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials

B. Debriefing materials: See Appendix C

C. Potential debriefing topics

1. Team dynamics
   a. Leadership
   b. Collaboration
   c. Communication
   d. Professionalism
2. Didactic material
   a. Appropriate differential diagnosis, including various illicit intoxication: Cocaine, Amphetamine, Crystal meth, Anticholinergics (e. reduced sweating and garbled speech, "mouthful of marbles"), MDMA (diaphoresis and normal but pressured speech)
   b. Pathophysiology
      i. Differences in isolated amphetamine toxicity
      ii. Cardiovascular/CNS stimulation, hyperthermia, hyponatremia, serotonergic
   c. Symptoms and patterns of intoxication/toxidromes
   d. Management options
      i. Medical management of drug-related issues
      ii. Emergency management of seizure in this context
   e. History of MDMA (3,4 methylenedioxyamphetamine)
      i. 1914: Initially appetite suppressant
      ii. 1970s: Psychotherapeutic but found to be too addictive
      iii. Now: "circuit party" drug that induces euphoria, disinhibition, wakefulness, intimacy, sexual arousal

VIII. Development and Deployment

This case was developed and deployed for independent study sessions among first and second year medical students.

IX. Authors/Contributors

Case drafted by Kimberly Khoury, M.D., with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	13,000	4,500 - 10,000 K/uL	
Neutrophils (%)	90	54 – 62%	
Band forms (%)	2	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	0	0 – 3%	1 – 3%
Lymphocytes (%)	6	24 – 44%	25 – 33%
Monocytes (%)	3	3 – 6%	3 – 7%
Hemoglobin (HGB)	14.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	42.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	92	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	34	31 – 37 g/dL	
Platelet	430,000	100,000 - 450,000 K/uL	

COMPREHENSIVE METABOLIC PANEL		Reference Range	
Sodium	124	135-147 mmol/L	
Potassium	4.0	3.5-5.2 mmol/L	
Chloride	113	95-107 mmol/L	
CO_2	25	22-30 mmol/L	
Urea Nitrogen (BUN)	20	7-20 mg/dL	
Creatinine	1.7	0.5-1.2 mg/dL	
Glucose	95	60-110 mg/dL	
Alkaline Phosphatase	50	33 – 131 IU/L	51 – 153 IU/L

Aspartate Aminotransferase (AST)	35	15-50 IU/L
Alanine Aminotransferase (ALT)	23	6-50 IU/L
T. Bilirubin	0.9	0.1 – 1.2 mg/dL
Total Protein	6.3	6.3 – 8.5 g/dL
Albumin	4.0	3.5 – 5.0 g/dL

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	8	<10
Salicylates	4	<5
EtOH	0	0
Opiates	Negative	Negative
Cocaine Metabolites	Negative	Negative
Benzodiazepines	Positive	Negative
Cannabis Derivatives	Positive	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

ECG: sinus tachycardia
http://www.emedu.org/ecg/images/st_1a.jpg

XII. Appendix C : Interesting articles to discuss/reference

a) Kalant, H. The pharmacology and toxicology of "ecstasy" (MDMA) and related drugs. CMAJ 2001; 165:917.

b) Budisavljevic, MN, Stewart, L, Sahn, SA, Ploth, DW. Hyponatremia associated with 3,4-methylenedioxymethylamphetamine ("Ecstasy") abuse. Am J Med Sci 2003; 326:89.

c) Mueller, PD, Korey, WS. Death by "ecstasy": the serotonin syndrome?. Ann Emerg Med 1998; 32:377.

Narcotic Overdose

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Physical examination
☐	Supplemental O_2
☐	IV fluids
☐	Empiric Narcan and glucose
☐	Obtain appropriate laboratory studies: CBC, BMP, fingerstick, toxicology screen
☐	Obtain appropriate images: CXR, ECG
☐	*Airway management*

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   3. Radiologist: reads chest x-ray
   4. Cardiologist: reads ECG

V. Case Narrative

PATIENT: 31 year old
CC: Altered mental status

HPI: *Use lay terminology as the voice of the patient*

****Per EMS*: Friend called EMS after he found patient on apartment couch and was not acting himself. Friend reports patient has no known drug allergies or significant past medical history. No further history possible secondary to decreased mental status. Patient not following commands, occasionally yells "Get me outta here" or "leave me alone."

Vitals on scene:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
70	120/84	37.0^o	98%	8

PMHx:
***Per friend: Non-contributory

MEDICATIONS	ALLERGIES
Unknown	NKDA

PSHx/SOCIAL Hx/FAMILY Hx/ROS: Unknown

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
78	110/84	37.0^o	98%	6

GENERAL: Confused
HEENT: Atraumatic, 1mm pupils
NECK: Supple, no JVD
PULM: CTAB, decreased RR
CV: RRR, no murmurs/rubs/gallops, 2+ pulses
ABD: Soft, NT/ND, +BS
EXT: No trauma, no c/c/e
NEURO: Pinpoint pupils, MAE x 4, grossly intact, exam limited due to poor cooperation

LABS: See Appendix A

***Pending until patient given Narcan empirically:

Amylase/Lipase Level		Comprehensive Metabolic Panel	X
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen (Urine, Serum)	X

Complete Blood Count (CBC)	X	Urinalysis	
CBC with differential		Urine HCG	

Additional Labs: fingerstick

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast	X	MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CLINICAL PROGRESSION:
Patient is initially responsive, complaining and confused, but becomes increasingly somnolent. Attempt to obtain a patient history followed by rapid physical and IV/O_2/monitor.

Events: pt unable to provide much history, somnolent, decrease RR until Narcan given.

As desired, can introduce more complex scenarios: polysubstance use, body packing, etc.

***If no Narcan given within 10 minutes, patient becomes apneic and O_2 saturation drops, necessitating intubation:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
88	110/84	37.0^o	Rapidly decreasing	0

***If Narcan given, patient awakens and is combative, vomiting.

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
80	110/84	37.0^o	98%	10

VI. Instructor Notes

A. Tips to keep scenario flowing
1. If participants are unsure of treatment, nurse can suggest contacting poison control for assistance which should be tailored to participant knowledge level.

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor
- Physical examination
- IV fluid resuscitation
- Empiric Narcan and glucose
- Appropriate lab workup: CBC, BMP, fingerstick, toxicology screen (urine, serum)
- Appropriate imaging: CXR, ECG

2. Potential complications/errors path(s):
- Failure to administer Narcan

3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
   1. Team dynamics
      a. Leadership
      b. Collaboration
      c. Communication
      d. Professionalism
   2. Didactic material
      a. Appropriate differential diagnosis of altered mental status: Electrolytes (hyper/hypo: Na, glucose, Ca), uremia, hepatic encephalopathy, infection (central and otherwise), head trauma, illicit substances, hypoxia/ hypercarbia, primary neurologic process
      b. Pathophysiology
      c. Treatment
         i. Initial workup: laboratory studies, studies, diagnosis-guided treatment
         ii. Discuss empiric role of Narcan/glucose
         iii. Discuss why Flumazenil is not given empircally
      d. Complications of mixed overdose

VIII. Development and Deployment

This case was developed for a widely subscribed fourth year medical school elective (emergency medicine/transition to internship), and has been used over several years as part of an instructional module for altered mental status/toxicology.

IX. Authors/Contributors

Case drafted by Tania Fatovich, MD and Nancy Oriol, M.D., with contributions and updates by the Gilbert Simulation Team. Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. References

a. Clarke, SFJ, et al. Naloxone in opioid poisoning: walking the tightrope. Emerg Med J 2005;22:612-616 .

XI. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	137	135-147 mmol/L
Potassium	4.0	3.5-5.2 mmol/L
Chloride	113	95-107 mmol/L
CO_2	25	22-30 mmol/L
Urea Nitrogen (BUN)	20	7-20 mg/dL
Creatinine	0.7	0.5-1.2 mg/dL
Glucose	95	60-110 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	9,000	4,500 - 10,000 K/uL	
Neutrophils (%)	55	54 – 62%	
Band forms (%)	24	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	14.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	42.0	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	92	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	34	31 – 37 g/dL	
Platelet	430,000	100,000 - 450,000 K/uL	

FINGERSTICK		Reference Range
Glucose	Normal	

TOXICOLOGY SCREEN		Reference Range
Acetaminophen	8	<10
Salicylates	4	<5
EtOH	Positive	0
Benzodiazepines	Negative	Negative
Cocaine Metabolites	Negative	Negative
Opiates	Positive	Negative
Cannabis derivatives	Negative	Negative
Barbiturates	Negative	Negative
Amphetamines	Negative	Negative

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

Head CT (if obtained): Negative
http://www.urmc.rochester.edu/smd/Rad/neuroimages/CThead.jpg

EKG: Nonspecific
http://bestpractice.bmj.com/best-practice/images/bp/139-3_default.jpg

Organophosphate Poisoning

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Secure airway
☐	*Administer antidote*
☐	Decontamination

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG
   3. Poison control / Toxicologist: recommends treatment plan

V. Case Narrative

PATIENT: 26 year old

CC: Nausea, vomiting, abdominal cramping

HPI: *Use lay terminology as the voice of the patient*

Patient was brought in by coworkers complaining of nausea, vomiting, and abdominal pain. Patient is confused and having trouble breathing as s/he relates that the symptoms began while at work on a landscaping job. The worker was alone in one area of the yard spraying for bugs when coworkers noticed patient to be vomiting and confused.

PMHx:
Denies

MEDICATIONS	ALLERGIES
Denies	NKDA

PSHx: Denies

SOCIAL Hx:
EtOH: Social
Tobacco: ½ pack/day
Illicits: Marijuana use
Occupation: Landscaper
Additional: Lives with wife, 2 kids

FAMILY Hx: Non-contributory

ROS:
(+) Nausea, vomiting, diarrhea, shortness of breath, diaphoresis, abdominal cramping, confusion, anxiety

(-) Fever/chills, chest pain, blood in stool

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
46	100/64	37.0^o	90%	32

GENERAL: Salivating, "crying," vomiting, diaphoretic
HEENT: Pinpoint pupils
PULM: Wheezing/rhonchorous
CV: Sinus bradycardia
ABD: Diffuse tenderness to palpation without focality, rebound or guarding, hyperactive bowel sounds
EXT: Occasional fasciculations

NEURO: Largely nonfocal without rigidity but unable to fully comply with exam

LABS: Pending throughout the case

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Toxicologist – Dr. Frank: Will recommend any tests and imaging forgotten in lab workup and will advise treating for organophosphate intoxication with airway control and adequate oxygenation, aggressive atropine, consideration of pralidoxime (2-PAM) and benzodiazepines and appropriate HAZMAT decontamination. Will recommend continuous close monitoring and re-evaluation.

CLINICAL PROGRESSION:
History and physical, IV/O_2/monitor. Students should recognize strong likelihood of organophosphate poisoning, take decontaminating actions, order laboratory studies and imaging studies. Patient will continue to complain about the symptoms: "Oh, my stomach! Please stop the vomiting and diarrhea" and ask for something to make her/him feel better. Labs will be pending throughout the case so students are expected to take action with suspected diagnosis of organophosphate overdose based on clinical presentation alone.

***If students give atropine the heart rate and blood pressure will normalize, if they the antidote (2-PAM), the muscle fasiculations will stop.

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
60	120/74	37.0^o	90%	32

VI. Instructor Notes

A. Tips to keep scenario flowing
   1. If students are unsure of pathology, instructor can prompt the students to create differential diagnosis by calling in as a consultant
   2. If airway management, oxygen therapy and atropine not initiated, nurse can verbalize need for supportive care

B. Scenario programming
   1. Optimal management path:
      - O_2/IV/monitor
      - History and physical examination
      - Aggressive airway management/oxygenation
      - Decontamination
      - Consider administering atropine

- Consult toxicology/poison control

2. Potential complications/errors path(s):
   - Failure to protect airway, provide oxygen
   - Failure to provide antidote
3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
   1. Team dynamics
      a. Leadership
      b. Collaboration
      c. Communication
      d. Professionalism
   2. Didactic material
      a. Pathophysiology
         i. Review/reinforce parasympathetic function
         ii. Rest and digest → Cholinergic excess
         iii. ACh accumulation throughout the nervous system results in overstimulation of muscarinic and nicotinic receptors
         iv. Pesticide poisonings are the most common modes of poisoning fatalities
      b. Presentation
         i. SLUDGE: salivation, lacrimation, urination, defecation, gastric distress, emesis
         ii. BBB: bradycardia, bronchorrhea, bronchospasm
         iii. DUMBBELS: defecation-diaphoresis, urination, miosis, bronchorrhea, bradycardia, emesis, lacrimation, salivation
      c. Treatment
         i. Atropine, atropine, atropine (and more atropine until respiratory secretions decrease)
         ii. Pralidoxime (2-PAM)
         iii. Emphasis that organophosphate toxicity is a clinical diagnosis

VIII. Development and Deployment

This case was developed as part of a graduate-level science course (college, PhD students), and has been deployed as a standard course offering. Variants have also been used to teach medical students as part of an instructional pharmacology module.

IX. Authors/Contributors

Case drafted and revised by Nancy Oriol, M.D., Tania Fatovich, M.D., and Emily Hayden, M.D., with contributions and updates by the Gilbert Simulation Team. Compiled and formatted by Elan Guterman. Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

***If requested, pending throughout the case

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

ECG: Sinus Bradycardia
www.emedu.org/ecg/crapsanyall.php

XII. Appendix C: Teaching Materials

http://depts.washington.edu/opchild/images/ach.jpg

XIII. Appendix C: Interesting articles to discuss/reference

a) Chuang FR, Jang SW, Lin JL, Chern MS, Chen JB, Hsu KT. *QTc prolongation indicates a poor prognosis in patients with organophosphate poisoning*. Am J Emerg Med. Sep 1996;14(5):451-3.

b) Schier, JG, Hoffman, RS. *Treatment of sarin exposure*. JAMA 2004; 291:182.

PULMONARY CASES

Gilbert Program in Medical Simulation

Harvard Medical School

Asthma Exacerbation

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	Administer β-agonist (albuterol)
☐	Administer antimuscarinic (Ipraropium)
☐	Administer corticosteroid (Prednisone)

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values
   3. Images
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG

V. Case Narrative

PATIENT: 25 year old
CC: Shortness of breath

HPI: *Use lay terminology as the voice of the patient*

Patient has been previously healthy. Patient went on his/her daily run but decided to take a new route this morning. As the patient was out running past a construction site, s/he started having difficulty breathing. Patient slowed down the pace but still became increasingly short of breath and anxious. After returning home, patient immediately decided to drive to the hospital.

PMHx: Asthma

MEDICATIONS	ALLERGIES
'inhaler' but ran out several months ago	Seasonal, "never this bad"

PSHx: Unremarkable

SOCIAL Hx:
EtOH: Occasional
Tobacco: Denies
Illicits: Occasional marijuana
Occupation: Student
Additional: Lives with 2 roommates, takes many vitamins

FAMILY Hx:
Father: MI, age 55 (still alive)

ROS:
(+) Dyspnea, diaphoresis

(-) No nausea, vomiting, fever/chills, diarrhea/constipation, headache, blurred vision, lightheadedness, palpitations, numbness/motor weakness, abdominal pain, nor urinary symptoms. No sick contacts nor recent hospitalizations.

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
112	130/90	37.5^o	94%, decreasing	24

GENERAL: Anxious, short of breath and speaking in 3 word sentences
HEENT: PERRL/EOMI, MMM
NECK: Supple, No JVD
PULM: Bilateral wheezes with prolonged expiration
CV: Tachycardic, no murmurs
ABD: Soft, NT/ND, +BS

EXT: No edema or rashes
NEURO: WNL, MAE X 4, grossly intact

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiology – Dr. Jones: ECG, if obtained, is read as normal sinus tachycardia.

Radiology – Dr. Smith: CXR is normal.

CLINICAL PROGRESSION:
History and physical, IV access, and monitor. Patient has decreasing O_2 saturation, increasing fatigue, and increasingly short of breath until nebulized albuterol administered and supplemental O_2 provided. Participants are expected to recognize and treat low O_2 saturation, build a thorough differential diagnosis, order appropriate laboratory studies/images, and determine need for admission. Once participants administer O_2, bronchodilators, and steroidal medication, case will end. *Alternatively, can progress to increased dyspnea with expectation that advanced interventions such as magnesium, heliox, and intubation will be employed.*

***If inhaler is used to provide medication, patient cannot take in a dose before needing to take a breath and does not improve.

***Failure to give supplemental O_2 and nebulized medication within the first 10 minutes of the case will result in increasing tachycardia and decreased O_2 saturation, the vitals will read:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
130	130/75	37.0^o	88%	32

***If single dose of nebulized β-agonist (albuterol) and/or antimuscarinic (ipratropium) administered alongside supplemental O_2, shortness of breath and wheezing improve:

HR	BP	Temperature (^oC)	O_2 Sats (NRB)	RR
120	130/90	37.5^o	98%	18

***If continual nebulized albuterol, antimuscarinic medication (ipratropium), and steroids (prednisone) administered, blood pressure and respiratory rate normalize. Shortness of breath and wheezing are completely resolved.

VI. Instructor Notes

A. Tips to keep scenario flowing
   1. If students are unsure of pathology, prompting can come in form of a primary care physician calling to check in on his patient.
   2. If supplemental O2 is not provided, nurse can verbalize need for supportive care as patient becomes increasingly dyspneic

B. Scenario programming
   1. Optimal management path:
      - O2/IV/monitor
      - History and physical examination
      - Appropriate lab workup (none needed): CBC, BMP
      - Appropriate imaging (none needed): CXR, ECG
      - Stacked nebulized β-agonist and antimuscarinic
      - Administer corticosteroid (prednisone)
   2. Potential complications/errors path(s):
      - Failure to administer O2
      - Failure to administer medications via nebulizer
   3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials
C. Potential debriefing topics
   1. Team dynamics
      a. Leadership
      b. Collaboration
      c. Communication
      d. Professionalism
   2. Didactic material
      a. Presentation
         i. A decreased respiratory rate does not always mean the patient is improving
      b. Pathophysiology
      c. Etiology
         i. Exacerbation triggers
         ii. Differential diagnosis: pneumothorax, CHF exacerbation, pneumonia, pleural effusion, foreign body
      d. Treatment
         i. Treatment strategies: short-acting vs. long-acting medications
         ii. Factors determining whether to admit patient to hospital
         iii. Chest xray useful in first time wheeze, or apparent infectious symptoms

iv. *RSI medication selection in asthma (consider use of ketamine)*
v. *Ventilator settings in the intubated asthma patient*
    1. *high FiO2*
    2. *"Permissive hypercapnia" to minimize airway pressures (decreased tidal volumes and/or respiratory rate) and avoid pneumothorax*

VIII. Development and Deployment

This case, along with it precursors (reference Gordon, below) and variants have been used over several years for a wide range of students, including high school, college, masters/PhD candidates, medical students (preclinical and clinical) and resident trainees. The presentation and progression is tailored to the level of the learner; often the Asthma case is paired with the COPD case to allow students to compare and contrast diagnosis, anatomy, physiology, and management. It is commonly used as part of a "train the trainer" curriculum for faculty development in the use of simulation.

IX. Authors/Contributors

Case drafted by the Gilbert Simulation Team with group updates and contributions.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. References

a) US Department of Health and Human Services, National Institute of Health, National Heart, Lung, and Blood Institute, Expert Panel Report 3: guidelines for the diagnosis and management of asthma. Accessed February 25, 2010. http://www.nhlbi.nih.gov.ezp-prod1.hul.harvard.edu/guidelines/asthma/asthgdln.pdf

b) Gordon, JA. Macy Cases for Realistic Patient Simulation in Critical Care and Emergency Medicine. Harvard Medical School, Boston: President and Fellows of Harvard College, 2002

XI. Appendix A: Lab Values

BASIC METABOLIC PANEL		Reference Range
Sodium	139	135-147 mmol/L
Potassium	3.7	3.5-5.2 mmol/L
Chloride	98	95-107 mmol/L
CO_2	26	22-30 mmol/L
Urea Nitrogen (BUN)	51	7-20 mg/dL
Creatinine	1.1	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	7,500	4,500 - 10,000 K/uL	
Neutrophils (%)	57	54 – 62%	
Band forms (%)	8	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	3	0 – 3%	1 – 3%
Lymphocytes (%)	16	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%
Hemoglobin (HGB)	13.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.2	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	37	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	200,000	100,000 - 450,000 K/uL	

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

ECG: Sinus tachycardia
http://www.emedu.org/ecg/images/st_1a.jpg

COPD Exacerbation

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Vital signs
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Obtain appropriate laboratory studies: cbc, BMP, troponin
☐	Chest xray
☐	Administer β-agonist (albuterol)
☐	Administer antimuscarinic (Ipraropium)
☐	Consider corticosteroid (Prednisone)
☐	Consider antibiotic

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values
   3. Images
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray

2. Cardiologist: reads ECG

V. Case Narrative

PATIENT: 63 year old

CC: Shortness of breath, cough

HPI: *Use lay terminology as the voice of the patient*

Patient presents with productive cough with increasing sputum and shortness of breath for 2-3 days, cough x 4 months and shortness of breath x 2 days, which became markedly worse this morning. Cough was initially non-productive, then gradually began bringing up non-bloody, yellowish phlegm. Patient was hospitalized for 'breathing issues" last year but has no history of intubations.

***If asked, patient has history of heavy tobacco use and "mild asthma."

PMHx:
COPD: last steroids was 7 months ago
Arthritis

MEDICATIONS	ALLERGIES
Albuterol and Ipratropium inhalers Advair Naprosyn	NKDA

PSHx: Denies

SOCIAL Hx:

EtOH:	Social
Tobacco:	Quit
	***If pressed further, quit 3 days ago after 2 pack/day x 34 years
Illicits:	Denies
Occupation:	Owner, public relations company
Marital status:	Lives with wife, has 2 healthy kids (age 25, age 27)

FAMILY Hx: Unremarkable

ROS:
(+) Dyspnea, productive cough

(-) No nausea, vomiting, fever/chills, chest pain, headache, blurred vision, lightheadedness, palpitations, numbness/motor weakness, abdominal pain, or urinary symptoms

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
92	120/80	37.0^o	88%	24

GENERAL: Appears tired, able to speak in short sentences
HEENT: Ruddy faced, TM clear bilaterally, PERRL, EOMI, nares clear, OP erythematous
NECK: Supple, JVP not elevated
PULM: Somewhat barrel chested; diffuse wheezing bilaterally with poor air movement
CV: S1, S2, tachycardic, regular, no M/R/G
ABD: Soft, benign, no masses
SKIN: No rashes, warm to touch, cap refill <2 s
EXT: No edema, no cyanosis, mild digital clubbing

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas	X	Hepatic Panel	
Basic Metabolic Panel	X	Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

CONSULTS:
Cardiology – Dr. Jones: ECG will be read as normal sinus tachycardia.

Radiology – Dr. Smith: CXR will be notable for hyperinflation but without apparent opacities.

CLINICAL PROGRESSION:
History and physical, IV access, and monitor. Patient has decreasing O_2 saturation, increasing fatigue, and is increasingly short of breath until nebulized albuterol is administered and supplemental O_2 provided. Students are expected to recognize and treat low O_2 saturation, build a thorough differential diagnosis, order appropriate laboratory studies/images, and determine need for admission. Once students administer O_2, bronchodilators, and steroidal medication, case will end.

***If inhaler is used to provide medication, patient cannot take in a dose before needing to take a breath and does not improve.

***Failure to give supplemental O_2 and nebulized medication within the first 10 minutes of the case will result in increasing tachycardia and decreased O_2 saturation, the vitals will read:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
102	120/80	37.0^o	85%	27

***If single dose of nebulized β-agonist (albuterol), antimuscarinic (ipratropium) administered alongside supplemental O_2, shortness of breath and wheezing improve but patient cannot maintain O_2 saturation on room air:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
106	120/80	37.0^o	91% (O_2)	20

***If continual nebulized albuterol and antimuscarinic medication (ipratropium) administered along with O_2 therapy, blood pressure and respiratory rate normalize. Shortness of breath and wheezing are completely resolved.

For advanced participants, consider continuing scenario to include worsening respiratory decompensation after nebs, requiring PPV vs. intubation. Thus, after nebulizers, vitals read:

HR	BP	Temperature (^oC)	O_2 Sats (2L NC)	RR
125	140/92	37.0^o	79% (O_2)	36

VI. Instructor Notes

A. Tips to keep scenario flowing

B. If students are unsure of pathology, prompting can come in form of a primary care physician calling to check in on their patient.

1. laboratory studiesIf supplemental O_2 is not provided, nurse can verbalize need for supportive care as patient becomes increasingly dyspneic

C. Scenario programming

1. Optimal management path:
   - O_2/IV/monitor
   - History and physical examination
   - Appropriate lab workup: CBC, BMP, ABG
   - Appropriate imaging: CXR, ECG
   - Continual nebulized β-agonist and antimuscarinic
   - Consider corticosteroid (Prednisone)
   - Consider antibiotics
2. Potential complications/errors path(s):
   - Failure to administer O_2
   - Failure to administer medications via nebulizer
3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials: See Appendix C
C. Potential debriefing topics
    1. Team dynamics
        i. Leadership
        ii. Collaboration
        iii. Communication
        iv. Professionalism
    2. Didactic material
        i. Presentation
        ii. Pathophysiology
            1. COPD vs. Asthma
            2. Chronic bronchitis vs. emphysema
            3. CO2 retention (ABG with metabolic compensation)
        iii. Etiology
            1. Disease onset
            2. Exacerbation triggers
        iv. Treatment
            1. Reversibility of condition
            2. Need to provide antibiotics
            3. Factors determining whether to admit patient to hospital
            4. COPD management
            5. Adjunctive treatments: Noninvasive ventilation

VIII. Development and Deployment

This case, along with it precursors (reference Gordon, below) and variants have been used over several years for a wide range of students, including high school, college, masters/PhD candidates, medical students (preclinical and clinical) and resident trainees. The presentation and progression is tailored to the level of the learner; often the COPD case is paired with the Asthma case to allow students to compare and contrast diagnosis, anatomy, physiology, and management. It is commonly used as part of a "train the trainer" curriculum for faculty development in the use of simulation.

IX. Authors and their affiliations

Case drafted by the Gilbert Simulation Team with group updates and contributions.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

X. Appendix A: Lab Values

ARTERIAL BLOOD GAS		Reference Range
pH	7.32	7.35-7.45
pCO_2	50	35-45 mmHg
pO_2	80	60-100 mmHg
HCO_3	26	24-28 mmol/L
Sa O_2	91	97-100%
FiO_2	.21	.21

BASIC METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	3.5	3.5-5.2 mmol/L
Chloride	100	95-107 mmol/L
CO_2	28	22-30 mmol/L
Urea Nitrogen (BUN)	20	7-20 mg/dL
Creatinine	1.2	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	8,500	4,500 - 10,000 K/uL	
Neutrophils (%)	57	54 – 62%	
Band forms (%)	8	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	2	0 – 3%	1 – 3%
Lymphocytes (%)	32	24 – 44%	25 – 33%
Monocytes (%)	4	3 – 6%	3 – 7%

Hemoglobin (HGB)	13.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.2	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	32	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	200,000	100,000 - 450,000 K/uL	

XI. Appendix B: Diagnostic Studies

Chest X-Ray: Hyperinflated, no opacities
http://radiopaedia.org/images/266487

ECG: Sinus tachycardia
http://www.emedu.org/ecg/images/st_1a.jpg

XII. Appendix C: Teaching Materials

Diseased vs Healthy lungs: http://www.simplescience.org/Lessons/Medicine/Breath/Lesson0.htm

Anatomy of diseased alveoli: http://myhealth.ucsd.edu/library/healthguide/en-us/support/topic.asp?hwid=zm2394

XIII. Appendix D: References

a) Brochard L, et al. *Noninvasive Ventilation for Acute Exacerbations of Chronic Obstructive Pulmonary Disease*. NEJM 1995; 333(13): 817-22.

b) Skorodin MS, Tenholder MF, Yetter B, Owen KA, Waller RF, Khandelwahl S, et al. *Magnesium sulfate in exacerbations of chronic obstructive pulmonary disease*. Arch Intern Med. Mar 13 1995;155(5):496-500.

c) Saint S, et al. *Antibiotics in Chronic Obstructive Pulmonary Disease Exacerbations*. A Meta-Analysis. JAMA Mar 22 – 29 1995; 273 (12): 957 – 960.

d) Aaron SD, et al. *Outpatient Oral Prednisone after Emergency Treatment of Chronic Obstructive Pulmonary Disease*. NEJM 2003; 348 (26):2618-25.

e) Gordon, JA. Macy Cases for Realistic Patient Simulation in Critical Care and Emergency Medicine. Harvard Medical School, Boston: President and Fellows of Harvard College, 2002

Community Acquired Pneumonia

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Vital signs
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV fluid resuscitation
☐	Obtain appropriate laboratory studies: cbc, BMP
☐	Obtain chest xray
☐	Administer antipyretics
☐	Administer antibiotics

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. No moulage needed
   3. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values
   3. Images
D. Distracters: none

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist: reads chest x-ray
   2. Cardiologist: reads ECG

Case Narrative

PATIENT: 57 year old

CC: Shortness of breath, cough

HPI: *Use lay terminology as the voice of the patient*

Patient presents with fever and dyspnea. Patient reports 3 day history of SOB, sore throat, malaise, and low-grade fever. Patient recently developed productive cough. This morning, her/his fever rose to 103°F at which point s/he decided to drive to the hospital. Patient presents with yellow sputum, myalgias, right sided chest pain that is worse with deep breathing.

PMHx: Denies

MEDICATIONS	ALLERGIES
Ibuprofen, as needed Tylenol, as needed	NKDA

PSHx:
Appendectomy, age 18

SOCIAL Hx:
EtOH: 2 beers/night, "sometimes more on weekends"
Tobacco: Denies
Illicits: Denies
Occupation: Furniture dealer
Additional: Divorced and dating currently

FAMILY Hx:
Mother: Died of an MI at age 75
Father: Alive, age 86 but has colon cancer

ROS:
(+) Dyspnea, diaphoresis, subjective fever, myalgia

(-) No nausea, vomiting, diarrhea, chills, headache, blurred vision, lightheadedness, palpitations, numbness/motor weakness, abdominal pain, urinary symptoms. No sick contacts, recent hospitalizations, nor history of similar symptoms in the past.

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (°C)	O_2 Sat (RA)	RR
112	130/75	39.0°	92%	24

GENERAL: Nontoxic appearing, increased work of breathing, splinting with deep inspiration
HEENT: Pale conjunctiva, non-icteric sclera, MMM

PULM: Right (or left if L-sided pneumonia) chest with crackles, decreased breath sounds
CV: S1, S2, tachycardic, regular, no M/R/G
ABD: Soft, NT/ND, +BS
SKIN: No rash, warm to touch, cap refill <2 s
EXT: No edema or rashes

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	X
Arterial Blood Gas	X	Hepatic Panel	
Basic Metabolic Panel		Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	
Complete Blood Count (CBC)		Urinalysis	
CBC with differential	X	Urine HCG	

Additional Labs: blood culture, sputum culture

IMAGES: See Appendix B

Angiogram		ECG	X
CT Scan, with contrast		MRI	
CT Scan, without contrast		X-Ray	X
Echocardiogram		Ultrasound	

Additional Images: none

***CXR #1, RUL (Male)
***CXR #2, RLL (Male)
***CXR #3, RML (Female)

CONSULTS
Radiology – Dr. Smith: After asking participants for their interpretation, provides reading appropriate to xray chosen.

CLINCAL PROGRESSION:
History and physical, IV access, supplemental O_2 and monitor. Students are expected to recognize and treat low O_2 saturation and fever, build a thorough differential diagnosis, order appropriate laboratory studies/images, and determine need for admission when pneumonia has been confirmed. Once students administer O_2 and antibiotics as well as discuss future management, case will end.

Complexity can be added by providing some confounders in the history or physical, by altering the presenting vital signs or having the patient deteriorate, necessitating ventilatory support.

*** Patient improves with supplemental O_2 and antipyretic, but maintains oxygen saturation on room air. The vitals will reflect therapy given (NRB will change O_2 Sat, antipyretic will change temperature; both will lower heart rate):

HR	BP	Temperature (^oC)	O_2 Sats (NRB)	RR
105	130/75	37.0^o	97%	16

***Failure to give supplemental O_2 and antipyretic within the first 10 minutes of the case will result in increasing tachycardia and decreased O_2 saturation, the vitals will read:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
128	130/75	39.0^o	90%	28

V. Instructor Notes

A. Tips to keep scenario flowing

B. If students are unsure of pathology, prompting can come in form of a primary care physician calling to check in on their patient.

1. laboratory studiesIf supplemental O_2 is not provided, nurse can verbalize need for supportive care as patient becomes increasingly dyspneic

C. Scenario programming

1. Optimal management path:
   - O_2/IV/monitor
   - History and physical examination
   - Appropriate lab workup: CBC, CMP, and consider ABG, blood culture, sputum culture
   - Appropriate imaging: CXR, ECG
   - Administer antipyretics
   - Administer antibiotics
   - Determine need for hospital admission
2. Potential complications/errors path(s):
   - Failure to administer O_2
   - Failure to recognize need for antibiotics and possible hospital admission
3. Program debugging: N/A

VI. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials

B. Debriefing materials: See Appendix C

C. Potential debriefing topics

1. Team dynamics
   a. Leadership
   b. Collaboration
   c. Communication
   d. Professionalism
2. Didactic material
   a. Presentation
      i. Appropriate differential diagnosis
      ii. Based on the chest x-ray, discuss what would be expected on physical examination of the chest
   b. Pathophysiology
      i. Likely cause of acute febrile illness
      ii. Host defense mechanisms that are overcome for organism to cause pneumonia
   c. Etiology
      i. Understand differences between community acquired, nosocomial, and healthcare associated pneumonia

d. Treatment
    i. Factors determining whether to admit patient to hospital
    ii. PORT/PSI/CURB-65 score calculators and decision support tools available online
    iii. Choice of antibiotics
        1. Empiric
        2. Organism specific
    iv. *Ventilatory support*

VII. Development and Deployment

This case was developed as part of an integrated clinical teaching module for second-year medical students, and has been used over several years.

VIII. Authors and their affiliations

Case drafted by Emily Hayden, MD, with contributions and updates by the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard, M.D.

IX. References

a) Mandell, LA, et al. IDSA/ATS Guidelines for CAP in Adults. Clin Infect Dis 2007:44 (Suppl 2) S27-72.
b) http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/infectious-disease/community-acquired-pneumonia/#cesec6

X. Appendix A: Lab Values

ARTERIAL BLOOD GAS		Reference Range
pH	7.37	7.35-7.45
pCO_2	35	35-45 mmHg
pO_2	80	60-100 mmHg
HCO_3	26	24-28 mmol/L
Sa O_2	91	97-100%
FiO_2	.21	.21

BLOOD AND SPUTUM CULTURES		Reference Range
Blood Culture	Pending	N/A
Sputum Culture	Pending	N/A

COMPLETE BLOOD COUNT WITH DIFFERENTIAL		Reference Range	
		Male	Female
White Blood Cell (WBC)	10,500	4,500 - 10,000 K/uL	
Neutrophils (%)	85	54 – 62%	
Band forms (%)	8	3 - 5 (>8% indicates L shift)	
Basophils (%)	0.75	0 – 1%	0 - 0.75%
Eosinophils (%)	0	0 – 3%	1 – 3%
Lymphocytes (%)	4	24 – 44%	25 – 33%
Monocytes (%)	3	3 – 6%	3 – 7%
Hemoglobin (HGB)	13.0	13.5 - 16.5 g/dL	12.0 - 15.0 g/dL
Hematocrit (HCT)	39.2	41 – 50%	36 – 44%
Red blood cell (RBC)	4.8	4.5 - 5.5 M/uL	4.0 - 4.9 M/uL
RBC Distribution Width	10.0	< 14.5%	
MCV	90	80 – 100 fL	
MCH	37	26 – 34 pg	
MCHC	33	31 – 37 g/dL	
Platelet	200,000	100,000 - 450,000 K/uL	

COMPREHENSIVE METABOLIC PANEL		Reference Range
Sodium	136	135-147 mmol/L
Potassium	3.5	3.5-5.2 mmol/L
Chloride	100	95-107 mmol/L
CO_2	24	22-30 mmol/L
Urea Nitrogen (BUN)	20	7-20 mg/dL
Creatinine	1.2	0.5-1.2 mg/dL
Glucose	100	60-110 mg/dL
Calcium	9.3	8.7 - 10.7 mg/d
Total Protein	7.0	6.3 – 8.5 g/dL
Albumin	3.4	3.2 – 5 g/dL
Bilirubin, total (T. Bili)	1.0	0.1 – 1.2 mg/dL
Alkaline Phosphatase	70	30 - 125 units/L
Aspartate Aminotransferase (AST)	28	15 – 50 IU/L
Alanine Aminotransferase (ALT)	25	6 – 50 IU/L

XI. Appendix B: Diagnostic Studies

Chest X-Ray #1: RUL Pneumonia (Male)
http://www.med-ed.virginia.edu/courses/rad/cxr/pathology3chest.html

Chest X-Ray #2: LLL Pneumonia (Male)
http://medinfo.ufl.edu/~bms5191/pulmon/p3.html

Chest X-Ray #3: RML Pneumonia (Female) – select RML
http://www.meddean.luc.edu/lumen/MedEd/medicine/pulmonar/cxr/atlas/cxratlas_f.htm

ECG: Sinus tachycardia (fever, dehydration)
http://www.emedu.org/ecg/images/st_1a.jpg

XII. Appendix C: Teaching Materials

Blood Culture: S. Pneumoniae
http://pathmicro.med.sc.edu/Infectious%20Disease/s%20pneumoniae.jpg

Sputum Culture: S. Pneumoniae
http://www.buddycom.com/bacteria/gpc/spneumo4.jpg

PORT Score Calculator: http://www.mdcalc.com/psi-port-score-pneumonia-severity-index-adult-cap

TRAUMA CASES

Gilbert Program in Medical Simulation

Harvard Medical School

Head and Musculoskeletal Trauma: SDH and pelvic fracture and open tib/fib fracture

I. Target Audience: Medical Students, Residents

II. Learning and Assessment Objectives

Participants are expected to understand the scientific and humanistic issues underlying the disease assessment and treatment plan, and to critically consider and deploy the therapeutic options described Participants should provide a concise presentation of the patient to each physician consultant who participates in the exercise. Debriefing sessions by on-site clinical faculty is essential to discuss critical thinking and knowledge pathways, and to provide a forum for individual and team reflection on learning and practice goals. While the case descriptions are written with medical terminology, it is important that the provider and patient (i.e. the simulator) engage in authentic dialogue with lay terminology to reflect an actual patient encounter

Critical Actions Checklist:

DONE	CRITICAL ACTION
☐	Telemetry monitoring
☐	Patient history
☐	Physical examination
☐	Supplemental O_2
☐	IV Access
☐	Fluid resuscitation
☐	Appropriate laboratory studies: cbc, BMP, LFT, T&S, coags, (+/- HCG)
☐	Appropriate imaging
☐	Pelvis stabilization
☐	Airway management
☐	Transfer to Level 1 trauma center

III. Environment

A. Simulation room set up: Emergency Department
B. Manikin set up:
   1. High fidelity patient simulator
   2. Full-spinal immobilization
   3. Right proximal lower extremity injury (blood, deformity if available)
   4. Lines needed
C. Props:
   1. Code blue cart
   2. Lab values (see Appendix A)
   3. Images (see Appendix B)
D. Distracters: none, *hysterical family member may be used as appropriate*

IV. Actors

A. Nurse: facilitate scenario
B. Consultants *(optional for higher level residents who can provide interpretation on their own)*
   1. Radiologist
   2. Trauma Surgeon

V. Case Narrative

PATIENT: 19 year old
CC: Trauma, altered mental status, lower extremity injury

HPI: *Use lay terminology as the voice of the patient*

Patient is a young motorcyclist not wearing a helmet who spun out of control on the interstate and was brought by ambulance to a Level 3 trauma center. The medics found patient laying on the ground, combative and with an obvious deformity of his/her right proximal lower extremity which was splinted. At the scene, patient was not answering questions appropriately.

PMHx/ PSHx/ SOCIAL Hx: Unknown

MEDICATIONS	ALLERGIES
Unknown	Unknown

FAMILY Hx: Non-contributory

ROS: Cannot elicit from patient

PHYSICAL EXAM: *Those signs not demonstrable by the mannequin should be verbalized when students perform/verbalize the examination maneuver*

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
124	90/50	37.0^o	98%	18

GENERAL: Moderately combative, not answering questions appropriately, GCS 13
HEENT: Right parietal hematoma, PERRL 4 to 2mm, no facial tenderness, no hemotympanum, no septal hematoma, midface stable, dentition intact
NECK: C-collar in place, no midline tenderness or deformity; trachea midline
PULM: Clear to auscultation bilaterally, minor abrasions
CV: Tachycardic, reg rhythm
ABD: Soft, non-tender, road rash on right flank; FAST exam negative. Pelvis unstable.
BACK: No midline tenderness or deformity
EXT: Right open tib-fib fracture with loss of distal pulses to right lower extremity
NEURO: Moves all extremities
GU: Blood at urethral meatus, no gross blood on rectal exam with normal tone

LABS: See Appendix A

Amylase/Lipase Level		Comprehensive Metabolic Panel	
Arterial Blood Gas		Hepatic Panel	
Basic Metabolic Panel		Lactate/Cortisol Level	
Cardiac Markers		Thyroid Panel	
Coagulation Profile		Toxicology Screen	

Complete Blood Count (CBC)		Urinalysis	
CBC with differential		Urine HCG	

None available throughout case

Additional Labs: none

IMAGES: See Appendix B

Angiogram		ECG	
CT Scan, with contrast		MRI	
CT Scan, without contrast	x	X-Ray	X
Echocardiogram		Ultrasound	X

Additional Images: none

CONSULTS:
Radiology – Dr. Smith: *If necessary,* reads CT head as left subdural hemorrhage with midline shift, chest xray as normal, pelvic xray as open book pelvic fracture.
Surgeon – Dr. Lester: Recommends stabilization then transfer to Level I trauma center.

CLINICAL PROGRESSION:
History and physical, large bore IV access, and monitor. Patient has progressive hypotension. Participants are expected to aggressively resuscitate with fluids and blood products. Upon recognition of the various injuries, participants should consult trauma surgery, neurosurgery, and orthopedics, but will find that none are available and will need to stabilize patient for transfer to Level I trauma center.

***Failure to give IV fluids or blood within the first 5 minutes of the case will result in increasing tachycardia and decreased blood pressure. Similarly, after 10 minutes if the pelvis has not been wrapped, the vitals will progressively worsen*, *progressing to PEA arrest at the discretion of instructor*:

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
135	80/50	37.0^o	96%	20

***After 2L IVF or PRBC transfusion, tachycardia improves.

HR	BP	Temperature (^oC)	O_2 Sats (RA)	RR
106	100/70	37.0^o	98%	18

****For advanced participants, mental status can progressively worsen due to head trauma requiring difficult intubation.*

VI. Instructor Notes

A. Tips to keep scenario flowing
1. If students are unsure of pathology, instructor can prompt the students to create differential diagnosis and lead them towards imaging and laboratory studies necessary to confirm diagnosis
2. If fluid resuscitation is not provided, nurse can verbalize need for supportive care as patient becomes increasingly hypotensive.

B. Scenario programming
1. Optimal management path:
- O_2/IV/monitor

- History and physical examination
- Appropriate lab workup: CBC, Chemistry, Tox, Coags, Type and Cross
- Appropriate imaging: Portable chest and pelvis xray, FAST, leg xray, Head CT
- Pelvis stabilization
- Airway management
- Transfer to Level 1 trauma center

2. Potential complications/errors path(s):
    - Failure to administer fluids
    - Failure to stabilize pelvis
    - Failure to transfer
3. Program debugging: N/A

VII. Debriefing Plan

A. Method of debriefing: Group with multimedia teaching materials
B. Debriefing materials
C. Potential debriefing topics
1. Team dynamics
    a. Leadership
    b. Collaboration
    c. Communication
    d. Professionalism
2. Didactic material
    a. Presentation: General approach to trauma (primary/secondary survey)
    b. Pathophysiology: Pelvis fracture classification, Intracranial injuries
    c. Treatment: Indications for transfer, *RSI medication selection in head trauma patients*

VIII. Development and Deployment

This case has broadly been developed for medical students and residents.

IX. Authors and their affiliations

Case drafted by Jeffrey Siegelman, M.D., and Zoë Howard, M.D. with the Gilbert Simulation Team.
Compiled and formatted by Elan Guterman.
Reviewed and edited with references by Jeffrey Siegelman, M.D. and Zoë Howard

X. References

a) Burgess AR, Eastridge BJ, Young JW, et al. Pelvic ring disruptions: effective classification system and treatment protocols. *J Trauma*. Jul 1990;30(7):848-56.

b) DeAngelis NA, Wixted JJ, Drew J, Eskander MS, Eskander JP, French BG. Use of the trauma pelvic orthotic device (T-POD) for provisional stabilisation of anterior-posterior compression type pelvic fractures: a cadaveric study. *Injury*. Aug 2008;39(8):903-6.

c) Smits M, et al. External validation of the Canadian CT Head Rule and the New Orleans Criteria for CT scanning in patients with minor head injury. JAMA Sept 28 2005; 294 (12): 1519 – 1525.

XI. Appendix A: Lab Values: none available during case

XII. Appendix B: Diagnostic Studies

Chest X-Ray: Normal
http://www.rctradiology.com/icons/normalchest.jpg

AP pelvis:
http://www.itim.nsw.gov.au/images/Compound_Open_book_pelvic_fracture_2.jpg

FAST exam: negative

Right LE xray
http://orthopedics.about.com/library/xrayimages/fxaptibfib.jpg

Head CT: Subdural hematoma and midline shift

Image courtesy of Dr Jeffrey Siegelman, Massachusetts General Hospital