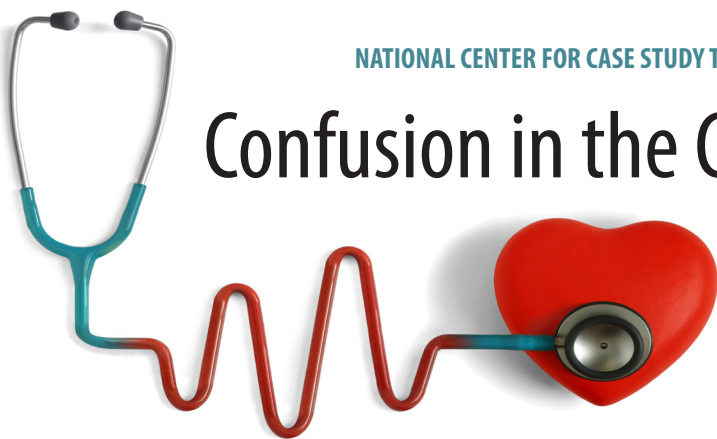


Confusion in the Cardiology Wing



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Part I – The Heart of the Matter

You recently graduated from Texas Tech University Medical School and have just started your first year of residency at Baylor Scott and White Medical Center. You and your co-residents are on a cardiology rotation. You all are in the lounge and are studying and quizzing each other on some typical cardiology terms and diagnoses.

Questions

1. Match the lettered term to the correct definition listed below.

A. Infarction B. Ischemia C. Hypoxia D. Cardiac Arrest E. Stroke F. Heart attack

- ___ Deficient supply of blood to a body part (such as the heart or brain) that is due to obstruction of the inflow of arterial blood.
- ___ A deficiency of oxygen reaching the tissues of the body.
- ___ When blood flow to the brain is impaired, resulting in oxygen deprivation and death of brain cells.
- ___ Temporary or permanent cessation of the heartbeat.
- ___ When blood supply to the heart muscle is severely reduced or cut off.
- ___ Injury or death of tissue (as of the heart or lungs) resulting from inadequate blood supply especially as a result of obstruction of the local circulation by a thrombus or embolus.

2. Using the definitions you just learned above, create a sentence or small paragraph below that correctly uses and relates all the terms from Question 1.

3. What do you think happens to the heart when its blood supply is severely reduced, restricted, or entirely cut off?

4. Watch the video below on myocardial infarction and then briefly describe what disrupts cardiac blood flow during a heart attack. (Note: dyspnea is labored or difficult breathing.)
 - *An Osmosis Video: Heart Attack Explained*. Running time: 12:39 min. Produced by Osmosis.org, 2018.
<<https://youtu.be/2kLlhlsesRQ>>

5. In the video, you learned about symptoms of a heart attack. List those here. Then, use the resource below to note which three symptoms are more common in women compared to men.
 - American Heart Association. (*n.d.*). Heart attack symptoms in women [webpage].
<<https://www.heart.org/en/health-topics/heart-attack/warning-signs-of-a-heart-attack/heart-attack-symptoms-in-women>>

6. Formulate a hypothesis about what type of tests would be useful in detecting a heart attack. You do not need to know specific names of tests (if you do, that is fine), but list the type of information you would want to gather. List two to three possible tests or procedures.

Part II – The Patient

The hospital is alerted that an ambulance is on the way with a patient, George Rodriguez, age 64, chest pains, with lightheadedness; suspected heart attack via a 12 lead ECG that was taken en route to the hospital. The EMTs notify your team that they started an IV and collected blood samples for cardiac biomarker labs. You and your team run down to the emergency room to meet the ambulance, help transfer the patient, and get the blood samples sent to the lab. Your attending physician says that the ECG reveals myocardial infarction (MI), and the patient will immediately need to be transferred to the catheterization (cath) lab so that a coronary angiogram can be performed. While you are waiting, you pull out your handy cardiac testing sheet primer [get this from your instructor] to quiz yourself on what other tests could have been useful if an MI were not already confirmed.

Questions

- Using the primer and your answers from Question 6 in Part I, choose four tests you think would be good identifiers of an MI. In the table below, provide a brief justification for, and the predicted results from, the tests.

<i>Test</i>	<i>Why</i>	<i>Predicted result</i>

- Draw a graph showing predicted troponin I, troponin T, and CK-MB levels in the bloodstream after a suspected myocardial infarction. For the x-axis use time and include hours 2–4, 24, and 48, as well as 7 days; for the y-axis you can list relative concentration.

Pat III – Arrival

Mr. Rodriguez has arrived at the hospital; the emergency department (ED) staff has taken him to the cath lab. You obtain the vitals, 12-lead ECG, and history from the EMTs. It is 8:55 a.m. You thank the EMTs, and rush to the cath lab, not far behind your patient. While the team preps Mr. Rodriguez for the angiogram and waits for the interventional cardiologist to arrive, you and your attending review the history the EMTs took in transit.

George Rodriguez; 64 yrs old; male

Arrived to work at 7:00 a.m. Shortly after arrival, he felt severe chest and neck pains, discomfort in his left shoulder, and became lightheaded. His employees became very worried and after some persuading, George allowed them to call 9-1-1. Vitals taken en route are listed below. George was given oxygen in the ambulance.

- Family history of cardiovascular disease
- Currently not on medication; no recent phosphodiesterase inhibitor use
- No surgeries in the last year
- No known allergies
- No history of blood clotting disorders
- History of untreated pre-diabetes and hypertension
- Four children
- Works many hours a week as manager; job stress; often works overtime
- No time to exercise
- Diet includes lots of fast food and convenience items
- Long-term smoker; one pack per day for 20 years

Table 1. Vitals of George Rodriguez; taken en route to ED.

Test	Normal Male Value	G. Rodriguez
Blood Pressure (mmHg)	120/80	155/95
Pulse (bpm)	60–100	110, regular
Oxygen Saturation (%)	95–100	89

Question

9. Are any of Mr. Rodriguez's vitals out of typical range? If so, which ones and in which direction?

You now compare Mr. Rodriguez's results with a typical reference ECG. Figure 1 is the ECG tracing from Mr. Rodriguez and Figure 2 is a typical ECG for comparison.



Figure 1. ECG from G. Rodriguez.

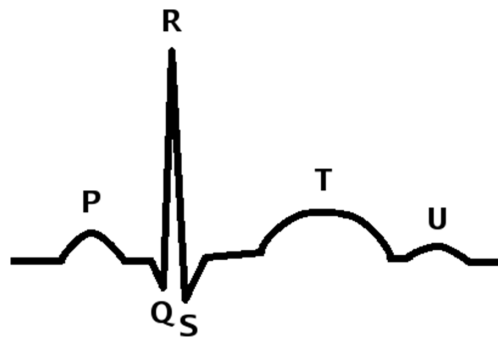


Figure 2. Normal ECG. *P*: depolarization of the atria. *QRS*: depolarization of the ventricles; repolarization of atria. *T*: repolarization of ventricles.

Question

- Compare the two images. Describe the differences between the typical ECG and Mr. Rodriguez’s ECG. How do these images compare to those you saw in the video in Part I? Explain.

The cardiac biomarkers blood test results are in. Even though everyone is fairly certain Mr. Rodriguez is having an MI, your attending physician wants you to analyze the labs for good measure.

Below are the results that you ordered for cardiac isoenzyme and protein testing. It is now 9:00 a.m.

Table 2. Test results for G. Rodriguez, 9:00 a.m.

Test	Normal Value	G. Rodriguez	High or Low?
cTnI (ng/mL)	< 0.04	1.5	
cTnT (ng/mL)	< 0.014	0.72	
CK-MB (IU/L)	5–25	37	
CK-MB2:CK-MB1	1:1	2.5:1	

Question

- Are any of the cardiac biomarkers out of typical range? If so, list them and describe what these results suggest.

Just before the coronary angiogram procedure begins, your attending physician explains that Mr. Rodriguez's ECG results reveal ST elevation in the anterior leads. These results suggest early repolarization of the ventricles and this ECG pattern is an indication of a heart attack. The blood work also shows consistent biomarker signatures of a heart attack. During the angiogram, the interventional cardiologist will restore blood flow to the heart via an angioplasty-balloon or a stent placement; this is typically paired with medication to diffuse the clot and open the occluded artery. After the procedure, Mr. Rodriguez will be transferred to the cardiac care unit (CCU) to monitor for arrhythmias, returning symptoms, and bleeding.

Mr. Rodriguez is nervous; he asks what an angiogram is and why it is being done. Your attending physician asks you to explain.

Question

12. Explain the procedure to the patient. What is an angiogram and why would it be helpful here? What results do you expect from this test?

The risks and benefits were explained and informed consent for the procedure was obtained from the patient. Being mindful of time, you tell Mr. Rodriguez that you will have further updates for him following the procedure. It is now 9:15 a.m. and it is time for the coronary angiogram to begin.

The angiogram shows 90% occlusion of the left anterior descending coronary artery, likely due to plaque rupture followed by formation of a clot.

The attending physician asks you what you expect for Mr. Rodriguez's further treatment and recovery plan. You explain that we will know more after thoroughly reading the angiogram, but Mr. Rodriguez should be able to return to work within two to six weeks. Mr. Rodriguez will be ordered cardiac rehabilitation and receive an exercise prescription from an exercise physiologist. While in cardiac rehabilitation, the nurse and dietitian will construct an individualized treatment plan addressing behavioral modifications, including diet, stress reduction techniques, smoking cessation, and the importance of taking medications as prescribed. Mr. Rodriguez will come to the rehab center and will be monitored during exercise three times a week for 8 to 12 weeks.

Your attending physician is satisfied with your response and tells you to follow up with Mr. Rodriguez after his procedure.

Part IV – The Next Patient

Now that Mr. Rodriguez will be monitored by CCU staff, you decide to get a bite to eat before visiting him in recovery and providing his update. As you walk to the cafeteria, you pass the neurology wing where you see a woman holding her back and looking very uneasy. You ask her if she is alright and she says she is short of breath, has back and upper chest pain, and is feeling a little nauseous. You immediately call a rapid response, which provides you with help to transfer the woman to the emergency room. It is 9:45 a.m.

As you and the nurses are rushing to the ER, you ask the women when she started to feel this way and try to take down her patient history as best as you can.

Her name is Susan Jones, and she is here today with her husband Mike Jones. Mike was diagnosed with an inoperable brain tumor yesterday; today's tests show the tumor is an aggressive form of cancer. Susan says that she was having trouble processing what the doctor was saying so she stepped out of the room to get a drink of water; she also felt like she was going to throw up. About 10 minutes before you saw Susan, she had received a call that her 25-year-old daughter had been in a severe car accident and was undergoing surgery in a different state.

Susan did her best to explain that she had felt overwhelmed at Mike's diagnosis, but shortly after hearing her daughter's condition she became very short of breath, lightheaded, and had intense back pain. That is when she ran into you.

Susan is in her late fifties and works as an accountant. She goes to Jazzercise four times a week and does her best to eat healthy.

Question

13. You think back to the quizzing you were doing with your fellow residents earlier. What symptoms would you expect to see in a woman presenting with a heart attack? Do the ones Susan mentioned match up?

Due to the classic coronary symptoms you immediately do an ECG, perform a physical assessment, run a cardiac biomarker panel, and administer oxygen. You page your attending physician to meet you at the cath lab where you will review the results and discuss the next step. It is 9:55 a.m.

Figure 3 below is the readout from Susan's ECG.



Figure 3. ECG from S. Jones.

Question

14. What do you notice about Mrs. Jones' ECG? Is it normal? Is her ECG trace similar to or different from Mr. Rodriguez's ECG?

Seeing the ST elevation on the ECG tracing, the attending asks the nurses to begin prepping Mrs. Jones for a coronary angiogram because this has a high probability of being an MI. You expect to see similar results to Mr. Rodriguez's workup. Here is Mrs. Jones' cardiac biomarker panel.

Table 3. Cardiac biomarker panel for S. Jones.

<i>Test</i>	<i>Normal Female Value</i>	<i>S. Jones</i>
Blood pressure (mmHg)	120/80	140/90
Pulse (bpm)	60-100	120
Oxygen saturation (%)	95-100	90
CK-MB (IU/L)	5-25	28
CK-MB2:CK-MB1	1:1	1.1:1
CRP (C-reactive protein test) (mg/L)	<3	10
cTnI (ng/mL)	< 0.04	0.05
cTnT (ng/mL)	< 0.014	0.016

Questions

15. Are any of Mrs. Jones' values out of the typical range? If so, which ones and in which direction?

16. How do her values compare to Mr. Rodriguez's values? Complete Table 4 below.

Table 4. Comparison of values between G. Rodriguez and S. Jones.

<i>Test</i>	<i>Normal value</i>	<i>G. Rodriguez</i>	<i>S. Jones</i>	<i>Comparison</i>
cTnI (ng/mL)	< 0.04	1.5		
cTnT (ng/mL)	< 0.014	0.72		
CK-MB (IU/L)	5-25	37		
CK-MB2:CK-MB1	1:1	2.5:1		

Part V – The Hunch

You are a bit puzzled by the fact that Mrs. Jones' biomarker levels are not that high; you expected them to be higher. However, you start thinking that Mrs. Jones' cardiac event just started, and so it is still early in the process. Mr. Rodriguez did not come to the ER right away and his blood sample was taken about 90 minutes after the onset of symptoms. Mrs. Jones' blood sample was collected about 20 minutes after onset. You present the results and the ECG to your attending physician. While the two of you are discussing why the results could look this way, a nurse overhears you and says that she was just speaking to the husband of Mrs. Jones, and he mentioned Susan had said, "I feel scared to death, I think I'm going to puke," right after hearing her husband's diagnosis. Your attending physician immediately straightens up, runs to the computer and starts typing. She pulls up an article about takotsubo cardiomyopathy and tells you she has a hunch that this is what Mrs. Jones is suffering from.

You begin reading what this condition entails and watch a video as well.

- Harvard Health Publishing. (2020). Takotsubo cardiomyopathy (broken-heart syndrome). [Webpage]. <<https://www.health.harvard.edu/heart-health/takotsubo-cardiomyopathy-broken-heart-syndrome>>
- ECG and Echo Learning. (*n.d.*). Takotsubo cardiomyopathy (broken-heart syndrome, apical ballooning syndrome, stress-induced cardiomyopathy). Section 3, Chapter 10. [E-book]. [*Note: you do not need to read the whole page; scroll down to #11.*] <<https://ecgwaves.com/topic/ecg-st-elevation-segment-ischemia-myocardial-infarction-stemi/>>
- *Takotsubo Cardiomyopathy (short version)*. [Video]. Running time: 1:58 min. Produced by Celine Yoo, Molei Fu, and Sumin Lee, 2014. <<https://youtu.be/g0c0TQKZdPk>>

Questions

17. Read the documents listed above and watch the video. Pay particular attention to the mechanism of action of this condition, how it presents in the patient, and how it is similar to and different from a heart attack. Jot down your notes about these topics below.

Notes:

18. Which test do you think will differentiate between a heart attack and takotsubo cardiomyopathy?

Part VI – Diagnosis and Recovery

Your attending physician agrees that once the coronary angiogram is done an echocardiogram will confirm Mrs. Jones' diagnosis. The angiogram shows that there are no blockages in the coronary arteries, but the ejection fraction (the volume of blood pumped out of the left ventricle with each contraction) is low. Low ejection fraction suggests Susan's heart is not pumping efficiently, which could be due to damaged heart muscle tissue. Current research suggests echocardiogram provides the most accurate readings for assessing left ventricular function. You order the echocardiogram post coronary angiogram to visualize left ventricle function but are almost certain Susan has suffered from takotsubo cardiomyopathy.

After Mrs. Jones is settled into a room and being monitored, you and your attending physician come in to explain the results and treatment plans. You tell Mrs. Jones that she suffered from a condition commonly known as broken heart syndrome, which is thought to be caused by a rush of epinephrine or other stress-responsive hormones due to extreme stress. Takotsubo cardiomyopathy is often misdiagnosed as a heart attack due to the similar results from an ECG and cardiac biomarker panels. The ECG revealed an ST elevation, which is the first indicator of a myocardial infarction. The panel showed slightly elevated levels of cardiac biomarkers, but levels were below those typically seen with myocardial infarction. These low levels are at least partially explained by time course of symptom onset and blood sample collection. The coronary angiogram showed no blockages in the arteries, but low ejection fraction, which helped lead to ordering an echocardiogram. This test identified the ballooning left ventricle, a tell-tale characteristic of takotsubo cardiomyopathy. The attending physician adds that Mrs. Jones' treatment plan will include medication such as beta blockers (to decrease effects of epinephrine on the heart) and ACE inhibitors (to decrease blood pressure), which will help promote heart muscle recovery. Learning stress reduction techniques are important and follow-up echocardiograms to monitor the left ventricle status will be performed.

Susan stays in the hospital for two more days so you can monitor her progress and ensure she remains asymptomatic. Mr and Mrs. Jones later contact you to say that their daughter is still healing and will begin physical therapy in a few weeks but has made amazing strides.

