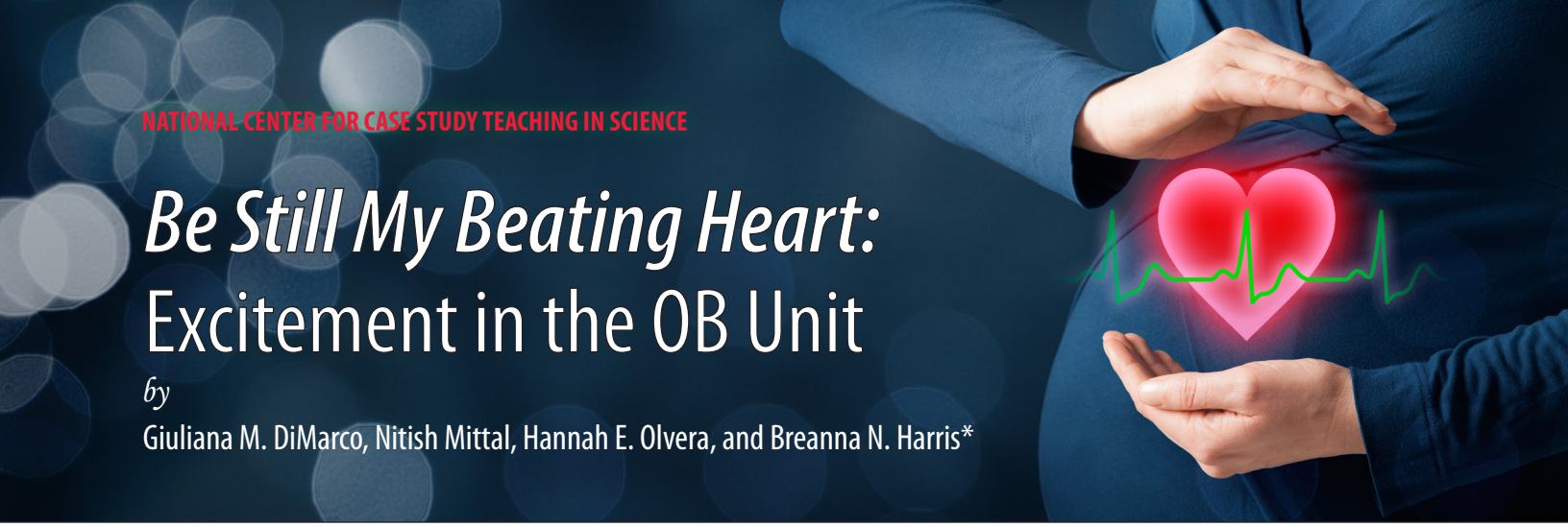
NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE



Be Still My Beating Heart: Excitement in the OB Unit

by
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Part I – Meeting the Patient

Nijha had known her entire life that she wanted to be a cardiologist, just like her grandmother. With this goal in mind she had worked hard and finished her first two years of medical school at the top of the class. Now was the time all medical students eagerly await ... rotations. Nijha just *knew* she was going to get the cardiology rotation first and she was bursting with excitement. But, on the day of assignment, her name was called with the group doing their OB/GYN rotation first. "No worries," she thought to herself, "besides, I have to do 24 rotations and I'm sure to learn something from each one. I can't wait to get started next week!"

Nijha reported to the OB/GYN unit the following Monday. Dr. Hernandez was the attending physician in OB/GYN and would take the lead on all the cases they would see.

Dr. Hernandez addressed the rotation cohort. "We've got lots of patients to see today so stay on your toes and keep up. Our first patient is Brittany Lam."

Dr. Hernandez told the group that Brittany was 36 years old and 35 weeks pregnant. She was experiencing sudden episodes of rapid heartbeat, shortness of breath, and dizziness. Although some shortness of breath is common with pregnancy, Dr. Hernandez wanted to be sure that everything was okay, especially because arrhythmias with pregnancy can be serious.

Dr. Hernandez asked the interns what tests they thought they should run. Steve, a fellow intern, suggested an ECG. "Correct," replied Dr. Hernandez.

Nijha couldn't help but be excited; she might actually get to do some cardiology in the first round!

Brittany was sent to the cardiology unit for her ECG and had some blood drawn. The team awaited the results. Dr. Hernandez told the interns that whoever correctly diagnosed Brittany and determined a treatment plan would get to assist with Mrs. Smith's delivery later that week. It might not be heart surgery, but delivering a baby on your first week sounded like a great start to Nijha.

That evening in the break room the group of interns got to work. First, they went over the basics of an ECG.

Questions

1. What is an ECG (or EKG as it is sometimes called)? What is it used for? (If you need to, you can use a website from a reputable source like the American Heart Association or MedlinePlus.)

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2. Draw the pathway for electrical conduction in the heart. Make sure to label the sinoatrial node, internodal pathways, the atrioventricular node, the bundle of His (AV bundle), the bundle branches, and the Purkinje fibers.

3. Fill out the table below describing the waves/parts of an ECG, what they represent, and where in the ECG image they are found.

Wave/part	*Represents*	*Portion of ECG image*
P-wave		
Q		
R		
S		
T-wave		

Aften the interns had reviewed the basics for a while, Nijha went over to the white board in the break room and drew an image of a typical ECG.

4. Draw a typical ECG and label all waves from Question 3.

As the interns continued their discussion, Iman went over to Nijha's drawing and added another ECG complex and labeled the PR interval, PR segment, the QRS complex (duration), the QT interval, and the ST segment. Shu, another intern, asked why each of those measures were important. Nijha was eager to answer and explained the following information.

5. Define PR interval, PR segment, the QRS complex (duration), the QT interval, and the ST segment, and explain what each represents in context to conductivity of the heart.

   PR Interval:

   PR Segment:

   QRS Complex:

   QT Interval:

   ST Segment:

6. Add another ECG complex to the drawing from Question 4 (or redraw below) and then add and label the PR interval, PR segment, QRS complex (duration), QT interval, and ST segment.

Shu also asked about the heart rate. Their patient Brittany had an arrhythmia (irregular heart rate), more specifically a rapid heartbeat, also called tachycardia. Dr. Hernandez mentioned how arrhythmias can be common and problematic during pregnancy. Shu said that this important piece of information (heart rate) should be readily available from an ECG.

Iman drew a grid (Figure 1 below) on the board and explained that the heart rate can be easily determined by counting blocks on the ECG paper. Time is shown on the *x*-(horizontal) axis and voltage is shown on the *y*-(vertical) axis. She

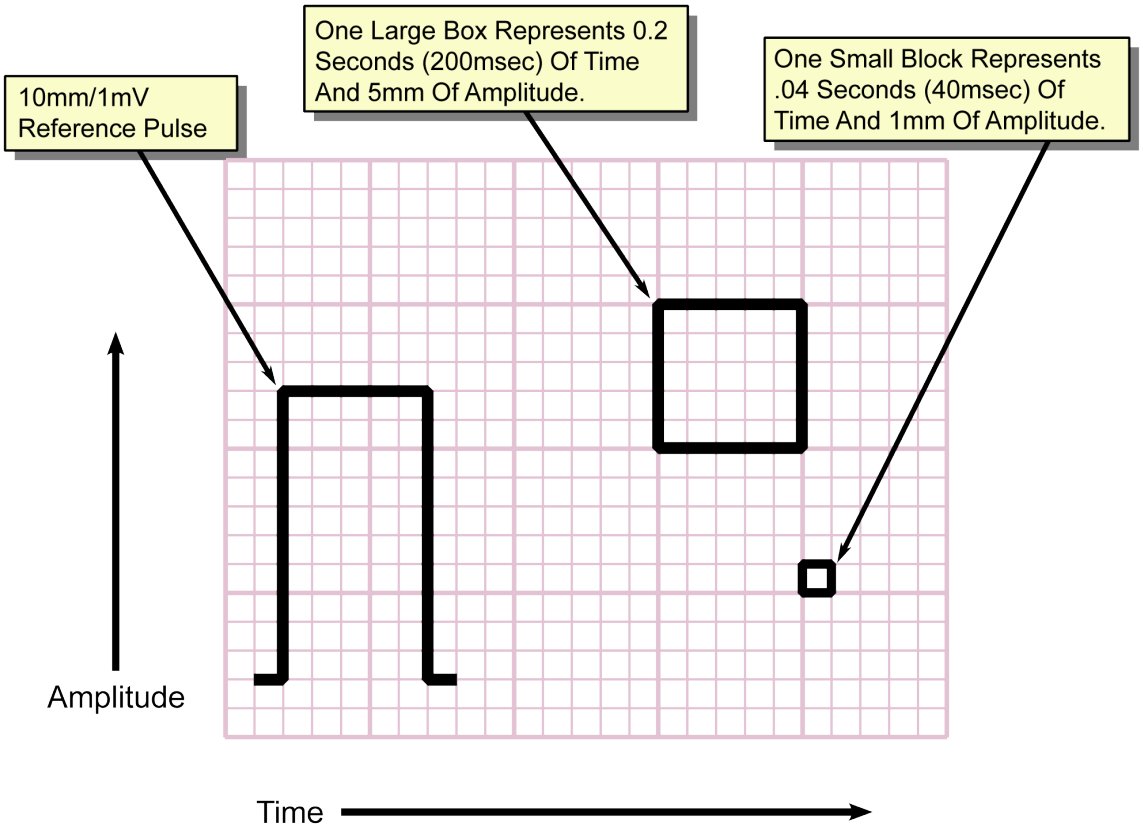

Figure 1. ECG paper.

explained that each large box is 200 msec of time (or 0.2 seconds), thus five of those large boxes is one second, and each little box is 4 msec of time (or 0.04 seconds). On the *y*-axis, each box is 0.1 mV. Strips are often run in either 6- or 10-second segments. To get the heart rate, one takes a distinguishable portion of the trace, for example the R section of the trace, and counts how many boxes there are between the first R and the next R. If there are five big boxes between one R and the next R that is a beat every second or 60 beats per minute (60/1). If there are two big boxes (400 msec between each R) then there is one beat every 0.4 seconds and the heart rate is 150 (60/0.4) beats per minute.

Iman then found a typical sinus rhythm reference strip on the computer and the interns all gathered aroud to look at Figure 2 below.

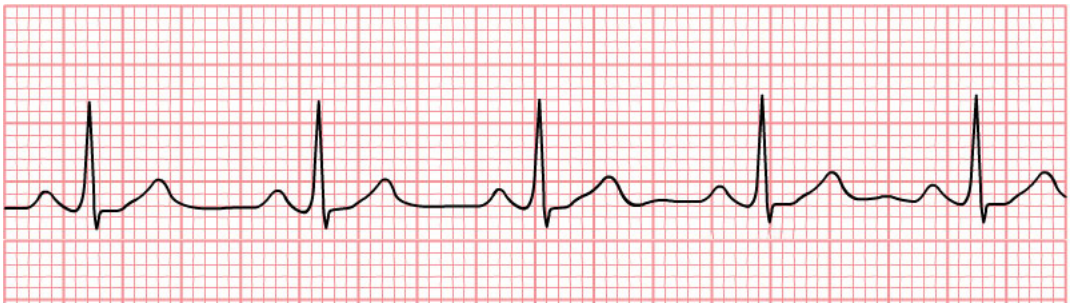

Figure 2. ECG diagram showing normal sinus rhythm.

7. What is the heart rate, in beats per minute, of patients whose trace is represented in Figure 2?

Part II – Test Results

The results from Brittany's ECG were in. The printout showed the following information.

Name: B. Lam Patient ID: 1525 Age: 36 Sex: F BP: 115/71 Date: 05/25/2018

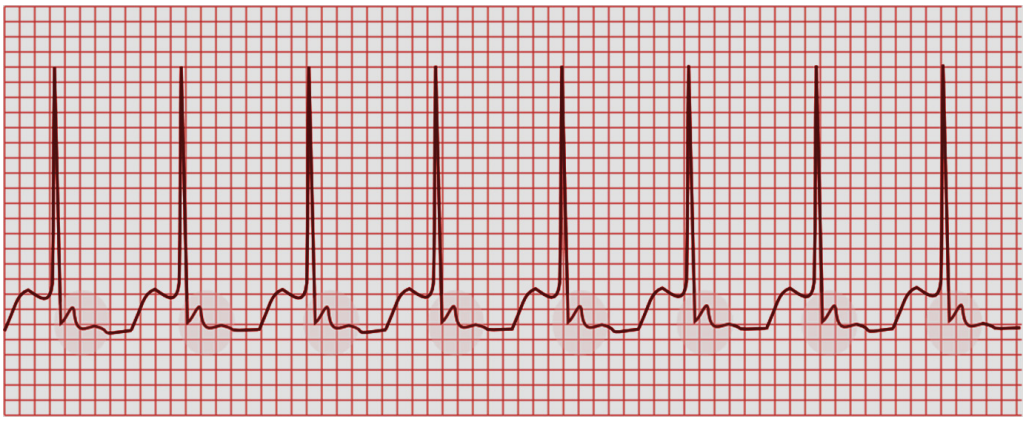

Figure 3. Brittany's ECG.

Questions

8. What is Brittany's heart rate?

9. Assume that typical resting heart rate for a healthy woman is around 75 bpm. What percent increase from that value is Brittany's?

10. What is the typical percent increase from baseline heart rate for someone who is 35 weeks pregnant? See the following paper for help:
    - Van Den Bosch, A. E., T.P. Ruys, and J.W. Roos-Hesselink. (2015). Use and impact of cardiac medication during pregnancy. *Future Cardiology*, 11(1): 89–100. <https://doi.org/10.2217/fca.14.68> (*Note*: you may need to use your school library to get full access.)

11. Compare Brittany's ECG to the normal sinus rhythm that Iman found (see Figure 4 below). What aspects of Brittany's ECG look different? (Be sure to use the ECG terms you learned above in your answer.)

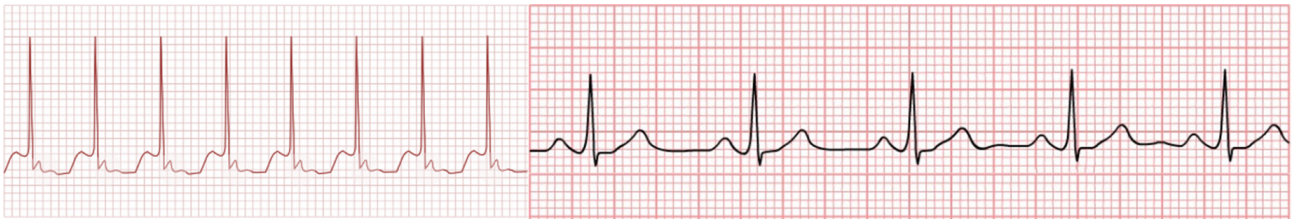

Figure 4. Comparison of Brittany's ECG (left) to normal (right).

Part III – Diagnosis

Nijha and the rest of the residents had been thinking hard about Brittany's signs and symptoms, as well as her ECG trace. Iman summarized what they knew so far:

Patient: Brittany Lam

- Brittany is 36 years old.
- 35 weeks pregnant.
- Experiencing sudden episodes of rapid heartbeat (tachycardia), shortness of breath, and dizziness.
- Tachycardia confirmed on ECG.
- Abnormal ECG trace (interpretation from cardiology); P wave hidden in the QRS complex; fast, narrow complexes.
- No underlying medical conditions (from patient history).

The residents started brainstorming possible diagnoses. They came up with an initial handful of options including sinus tachycardia, atrial tachycardia, atrioventricular nodal re-entrant tachycardia, ventricular pre-excitation (e.g., Wolff-Parkinson-White syndrome), atrial fibrillation, atrial flutter, and ventricular tachycardia. They then ruled out ventricular tachycardia and determined that the diagnosis was likely a type of supraventricular tachycardia (SVT) or paroxysmal supraventricular tachycardia (PSVT).

The interns found some helpful videos online. Nijha thought the patient likely had AVNRT (atrioventricular nodal reentry tachycardia), but Iman thought it was Wolff-Parkinson-White syndrome.

Questions

12. Explain what the ECG of someone with AVNRT would look like.

13. Explain what the ECG of someone with WPW would look like.

14. Based on what you know about Brittany and what you just learned about AVNRT and WPW, what do you think Brittany has? Why?

Part IV – Treatment

Based on discussion and the descriptions given by each resident, the group agreed with Nijha that Britanny had AVNRT. They presented their diagnosis to Dr. Hernandez and she agreed, but wanted to run a blood panel to check for thyroid and other hormone levels. The attending cardiologist thought this was a good plan as Brittany's symptoms had subsided and she did not need immediate conversion (procedure by which an arrhythmia is converted to a normal rhythm using electricity or drugs). The cardiologist then admitted Brittany and put her on a Holter monitor to record her heart function over the next few days. The baby was the priority, and since Brittany was almost to term they wanted to monitor her. The medical team might need to induce labor or schedule an emergency Cesarean section. Radiofrequency catheter ablation surgery might also be a good option for Brittany if symptoms persisted after delivery.

Nijha and Iman were still very interested in Brittany's case and did some more reading. They learned that AVNRT is common in women and can occur spontaneously during pregnancy. One of the most common medication treatments for these types of diseases is a beta blocker (or beta-adrenergic blockers). However, they also knew that their patient was pregnant, and this presented a limitation for treatment as various drugs could pass through the placenta and have unwanted effects on the developing fetus.

Questions

15. Generally, what is the impact of the hormones epinephrine and norepinephrine on the heart? Specifically, to which receptors do these hormones bind and what are the chronotropic (heart rate) and inotropic (contractility) effects?

16. What is the mechanism of action of the beta blocker?

17. Based on what you know about heart connectivity and AVNRT, why would a beta blocker be helpful in this case?

18. What are some of the documented concerns for giving beta blockers to pregnant women? Use Table 1 in the below paper to help you. (You may need to look up the names of common beta blockers to help you navigate this chart.)
    - Yaksh, A., L.J. van der Does, E.A. Lanters, and N.M. de Groot. (2016). Pharmacological therapy of tachyarrhythmias during pregnancy. *Arrhythmia and Electrophysiology Review* 5(1): 41. <https://doi.org/10.15420/AER.2016.1.2>

19. Using what you have learned or by using the below reference, what are some additional non-medicinal treatments that could be used? Why might these be helpful?
    - Brubaker, S., B. Long, and A. Koyfman, A. (2018). Alternative treatment options for atrioventricular-nodal-reentry tachycardia: an emergency medicine review. *The Journal of Emergency Medicine* 54(2): 198–206. <https://doi.org/10.1016/j.jemermed.2017.10.003>