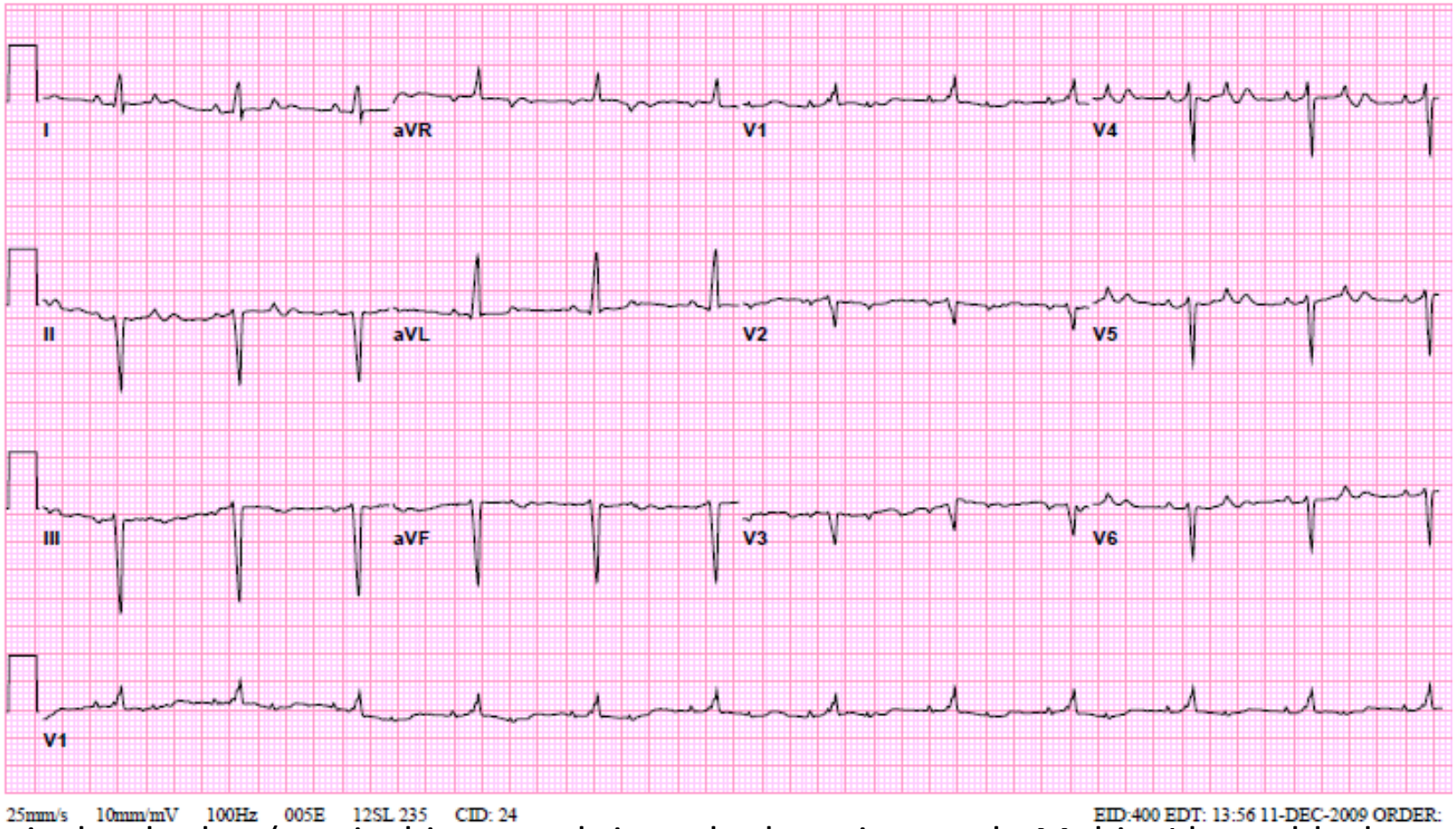
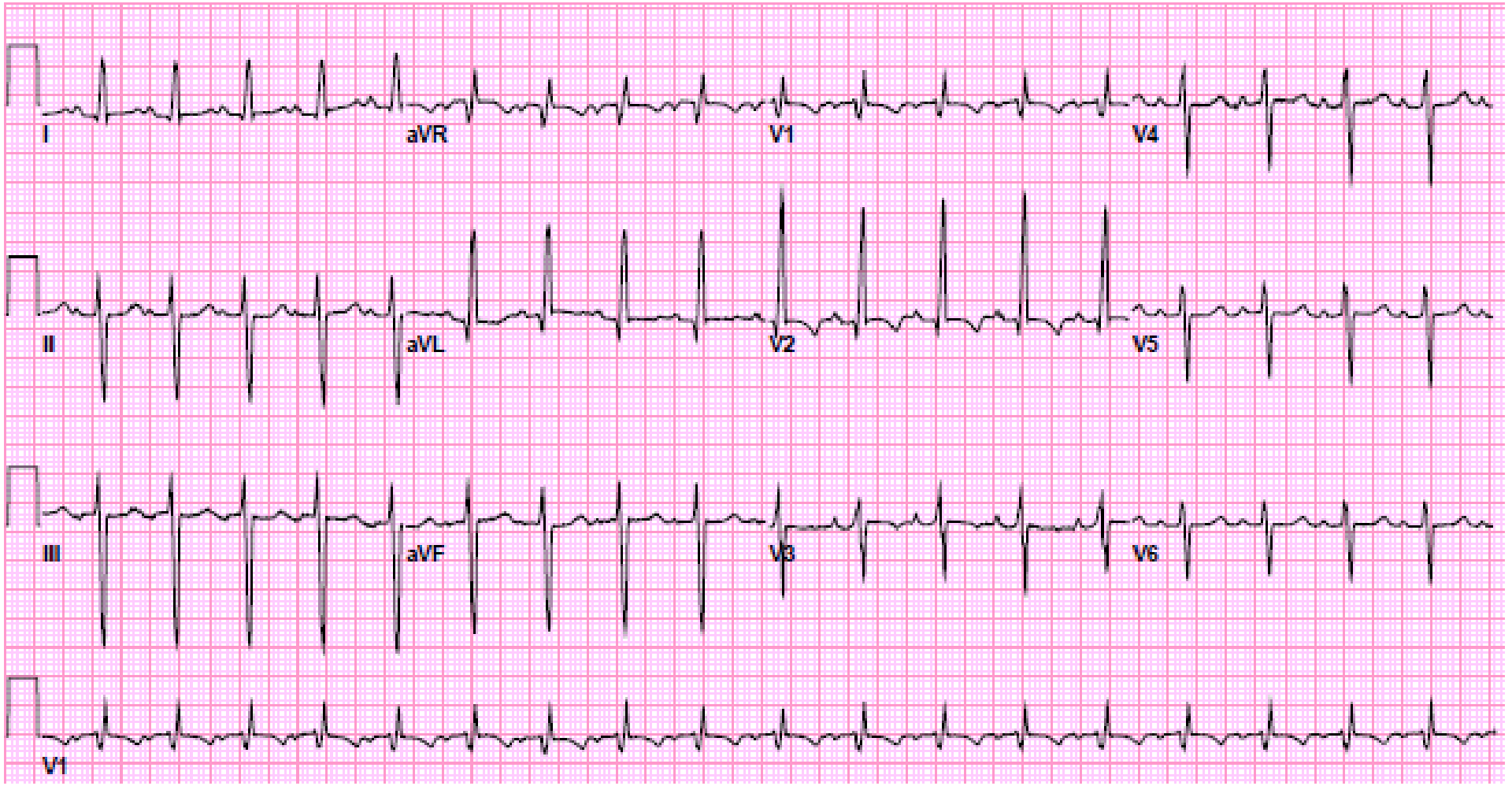
A newborn infant is admitted to the newborn nursery. One of the nurses notes a slow heart rate and an ECG is obtained, seen below [NOTE: the fact that lead V6 doesn't look exactly like lead I does not play a role in this case]:



1) What is the rhythm (e.g. is this normal sinus rhythm, sinus tach, Mobitz I heart block, etc)? [2 points]

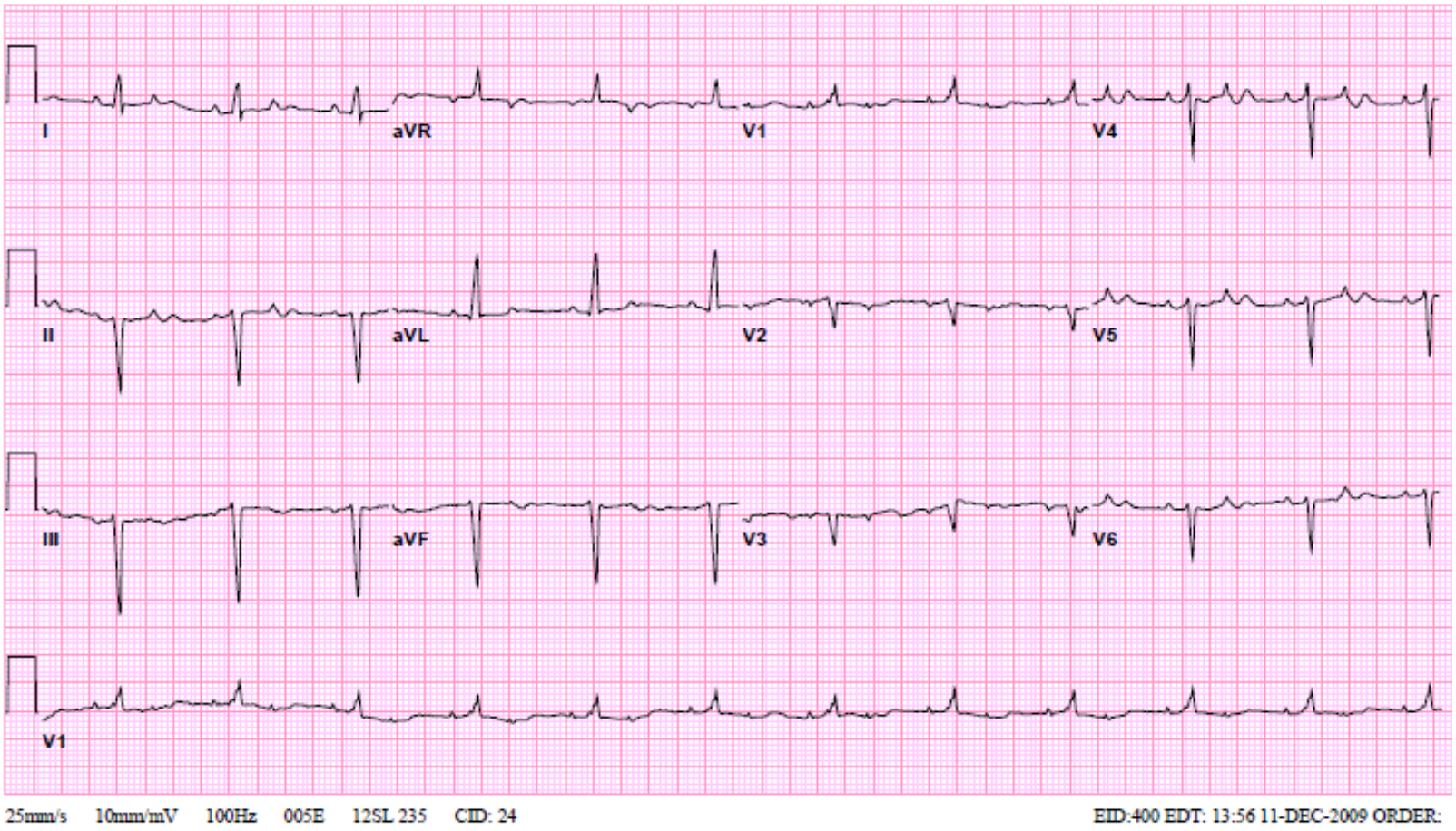
2) What 2 congenital, structural heart diseases can cause a newborn to have a QRS axis like this? [2 points]

The infant does well and is seen by a peds cardiologist, who starts the patient on propranolol, a beta-blocker. The follow up ECG is seen below:



3) Why did this patient's heart rate SPEED UP with beta-blockade?!? [2 points]

4) What is the patient's diagnosis? [1 point]



- 1) What is the rhythm (e.g. is this normal sinus rhythm, sinus tach, Mobitz I heart block, etc)? [2 points]

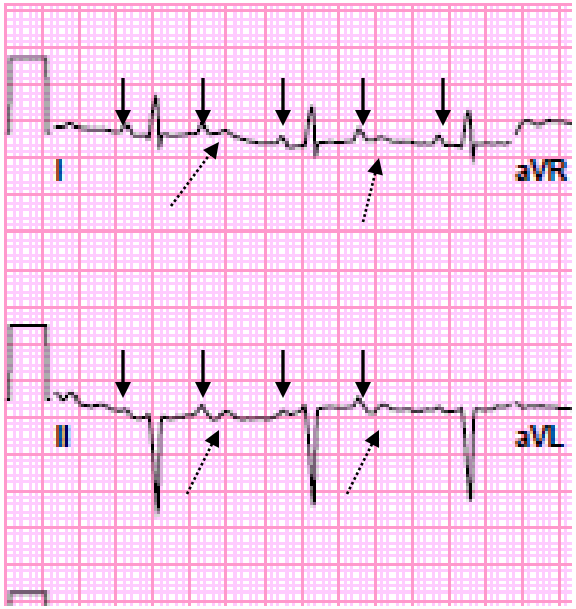
  The answer is 2:1 atrioventricular (AV) block. Acceptable answers are also 2nd degree heart block (in 2:1 block you can't differentiate between Mobitz I and II).

  Note that there are two P waves for each QRS complex. Therefore, only every other P wave is conducted to the ventricles.

- 2) What 2 congenital, structural heart diseases can cause a newborn to have a QRS axis like this? [2 points]

  This patient has a left superior axis (QRS is upright in lead I and downward in lead aVF).

  Two congenital heart problems that can yield this type of axis in a newborn infant are tricuspid atresia and AV canal defect (aka endocardial cushion defect).



What is critical in understanding this ECG is *why* he has 2:1 block. Look at this zoomed-in view of leads I and II. Vertical, downward arrows indicate P waves (note the regularity in which they occur) and the slanted upgoing arrows mark the end of the T wave.

Note that there is a P wave that comes just *before* the T wave. The T wave represents ventricular repolarization. Since the second P wave conducts to the ventricles while they are still repolarizing, the P wave is blocked! The following P wave then conducts normally.

3) Why did this patient's heart rate SPEED UP with beta-blockade?!? [2 points]

Beta blockers will slow down the sinus rate, thereby spacing out the P waves. If the P waves get spaced out enough, the second P wave in the tracing above would come *after* the T wave and thereby conduct through the ventricles. In other words, if The sinus rate is slowed down enough, the patient will be able to conduct every P wave reestablishing 1:1 conduction. Although the sinus rate slows from about 140 to 112bpm, when the sinus rate is 140 every other beat is blocked, yielding a ventricular rate of 70. Reestablishing 1:1 conduction *increases* the rate to 112, even though the sinus rate has actually slowed down! Is that cool or what!

4) What is the patient's diagnosis? [1 point]

Congenital long QT syndrome!!!