An ECG Selected at Random – What Do You See?

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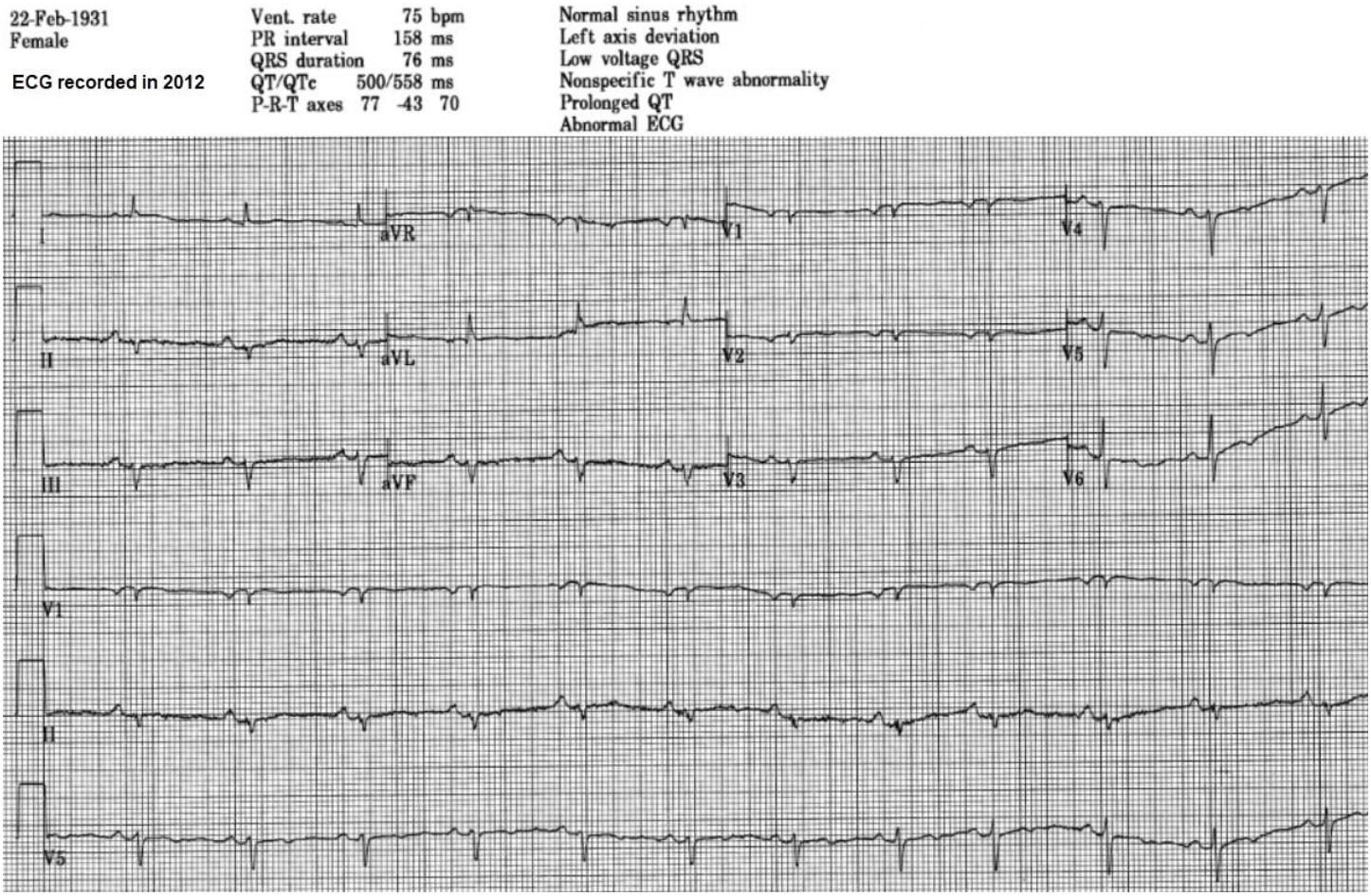

Figure 1

Here is an ECG that I selected at random from my collection. As you can see from the note I added, this patient was 81 years of age at the time the ECG was recorded. I know nothing about her except that the ECG was acquired in an emergency facility (an ER or an urgent care center).

Let's get the basics out of the way: there appears to be a sinus rhythm; no SA, AV or bundle branch blocks; no sign of acute ischemia; and there is no sign of chamber enlargement.

But here is what IS present: a QTc interval that is dangerously prolonged (greater than 500 msec), a non-specific T wave abnormality (the machine interpretation is correct this time), a left axis deviation and low voltage *in almost all 12 leads*.

Well, it appears that the prolonged QTc is perhaps the most serious problem on this ECG, so let's think about this. There are two kinds of long QT syndromes (LQTS): *congenital* and *acquired*. I doubt that this represents a congenital LQTS because 1) it is rare and 2) it's difficult

to imagine someone with a congenital LQTS living to 81 years of age. An acquired LQTS – which could be due to one or more of several unrelated problems – is quite possible, however. And, it is the most common form of LQTS. The most common cause would be a medication effect, likely followed by an electrolyte imbalance. In fact, it would not be unusual for *both* problems to be present simultaneously. We'll get back to this in a moment, but first I want to point out a few other observations…

Look at the P waves in the inferior leads – they are all large. Normally, Lead II has the largest P waves but in this case they are all large. Leads II and aVF appear to have P waves of approximately equal size. Why is that? If you look at the P wave axis printed on the tracing, you will see that it is +77°. That's almost exactly midway between the positive poles of Leads II and aVF. As the P wave axis moves closer and closer to +90°, its axis becomes more and more vertical. What if the P wave axis were exactly +90°? What should we see when examining the P waves? First, all the P waves in the inferior leads would be tall, but the P waves in Lead aVF would be the tallest since the P wave vector would be pointing directly at the positive pole of Lead aVF. The P waves in Leads II and III would be of equal size because they are equal distances from the positive pole of Lead aVF (30° on each side).

As the P wave axis moves closer to +90°, what change should we see in Lead I? The axis of Lead I is perpendicular to +90°, so as the P waves in the inferior leads get larger and larger, the P waves in Lead I should get smaller and smaller. Look in the ECG (Figure 1) to confirm this. Most P wave axes tend to cluster around +60° which also happens to be the Lead II axis. And the Lead II axis also happens to be exactly perpendicular to the axis of Lead aVL. Once the P wave axis (or QRS axis, also) moves past +60° toward the left, it will be in the negative territory of Lead aVL. Now look at the P waves in Lead aVL: they should be inverted – *and they are!*

Now a few other observations: normal PR interval, normal QRS duration, prolonged QTc, flat T waves (we'll get to the low voltage in a moment). What could cause this? *Hypokalemia!* Now why would this patient be hypokalemic? We don't know because we know nothing about her. Perhaps she has had diarrhea and vomiting with hypotonic fluid replacement. Or perhaps she has a villous adenoma or maybe she has been on a potassium-wasting diuretic.

While hypokalemia could very well cause all the aforementioned findings, it doesn't usually cause *low voltage*. What might do that? Of course the first thing you should do is *note specifically where the low voltage is manifesting*. What is the first thing you should check when you see low voltage? The *standardization curve!* It's always very embarassing when, after listing all the possible causes of low voltage during rounds, the attending physician points to a one-half standard standarization curve. If *only the limb leads* have low voltage or *only the precordial leads* have low voltage, then you are likely seeing the effects of a mean QRS axis (ÂQRS) that is directed almost entirely in either the frontal plane or the horizontal plane. This patient, however, exhibits low voltage in almost all the leads, so it must be something *other*

than an axis orientation. It could be a pleural or pericardial effusion, it could be due to hypothyroidism or – at 81 years of age – it could be due to amyloid infiltration. But remember – of all the things I just mentioned – *only hypothyroidism is a diagnosis*. The other conditions are signs of another problem. In an 81 year old woman, the effusions could be due to congestive heart failure, but they could also be due to renal failure or cancer. And a common cause of amyloidosis is multiple myeloma. Of course, you won't be able to diagnose amyloidosis during a single visit, but it's always something to consider in anyone over 60 years of age – and especially if it's mentioned in their medical record.

As much as it irritates me to say this, the machine print-out is correct – *this time!* But remember, ***the machine "interpretation" is NOT an interpretation*** – it's just a list of findings. ***It is still up to YOU to INTERPRET the results!***

Now, what would YOU like to add to this discussion?

I have listed a couple of articles available on the internet that you may find helpful.

Wang X, Han D, Li G. Electrocardiographic manifestations in severe hypokalemia. J Int Med Res. 2020 Jan;48(1):300060518811058. doi: 10.1177/0300060518811058. Epub 2018 Dec 4. PMID: 30509119; PMCID: PMC7287199.

Levis JT. ECG diagnosis: hypokalemia. Perm J. 2012 Spring;16(2):57. doi: 10.7812/tpp/12-015. PMID: 22745618; PMCID: PMC3383164.