NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

An Elderly Anomaly: A Realistic Integration of ECG, CBC, and PCR in Healthcare

by

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Part I – Electrocardiogram

Chester Fitzgerald is a 67-year-old Caucasian male who has just suffered an ischemic stroke. The doctor puts him on an anticoagulant and orders an ECG while he waits for Chester to wake up.

Table 1. ECG results for patient compared to normal values.

	Patient's Results[1]	*Normal Range*[2]
Heart rate	82 bpm	60–100 bpm
QT	420 ms	420 ms
QRS	110 ms	<120 ms
P duration	140 ms	< 100 ms
P amplitude	2.5 mm	< 2.5 mm
PR	170 ms	120–200 ms

Questions

1. Draw an ECG and label the following: P wave, Q wave, R wave, S wave, T wave, PR interval, QT interval, ST segment, QRS complex.

2. Describe what the P wave, T wave, PR interval, ST segment, and QRS complex indicate about the function of the heart.

3. How is Chester's ECG different from one that is normal? What are some possible causes of these differences?

Part II – Complete Blood Count

When Chester awakens, he reports that he's been experiencing headaches, fatigue, and dizziness for the last few months. The doctor also notes that Chester is flushed and sweating despite the cool room, and that he has inflamed joints. Upon conducting the physical exam, the doctor discovers that Chester's spleen seems to be enlarged. Once the anticoagulants are out of Chester's system, a complete blood count is done to determine the cause of the splenomegaly.

Table 2. CBC results for patient compared to normal values.

Tests	*Result*	*Flag*	*Units*	*Reference*[3]
WBC	12.9		$\times 10^3/\mu l$	4.4–11.3
RBC	6.7		$\times 10^6/\mu l$	4.50–5.90
Hemoglobin	20.8		g/dL	14.0–17.5
Hematocrit	63.4		%	41.5–50.4
MCV	84		fL	80.0–96.0
MCH	31.2		pg	27.5–33.2
MCHC	34.3		g/dL	33.4–35.5
RDW	13.6		%	11.7–18.0
Platelets	518		$\times 10^3/\mu l$	150–450

Questions

1. In the CBC column labeled "Flag," mark the test results that are out of the reference range.
2. Based on the CBC results, how would you expect Chester's blood smear to differ from a normal blood smear? Explain your answer.

3. What condition would you diagnose Chester with?

4. What could have caused this condition?

5. The lab also performed an EPO test to check erythropoietin levels in the blood. The report indicates that Chester's erythropoietin levels are low. What is erythropoietin and why are these results surprising?

Part III – Genetic Test

The doctor suspects that Chester is suffering from polycythemia vera, a blood cancer caused by a genetic mutation that results in overproduction of blood cells. This leads to thickening of the blood, causing many of the symptoms Chester's experienced. The doctor orders a genetic test to confirm the diagnosis.

Table 3. PCR gene sequence results[4] of *JAK2* T108A.

Patient:	G A G T C A G C C A G G C A T
Normal:	G A G T C A A C C A G G C A T

Questions

1. Describe the steps of PCR.

2. What type of mutation is shown by the patient's PCR sequence of the coding strand of the *JAK2* gene?

3. The *JAK2* gene is a proto-oncogene that codes for a tyrosine kinase. Patients, like Chester, with polycythemia vera have a mutated *JAK2* gene. In these patients, would you expect to see a gain-of-function or loss-of-function mutation?

Conclusion

After the diagnosis is confirmed, the treatment process begins. Chester is scheduled for regular phlebotomies, a bloodletting process that will help thin his blood. He's also ordered to hydrate well and is prescribed low-dose aspirin to reduce blood clotting and prevent further strokes. Chester takes well to the treatment, and is soon released from the hospital.

Data Sources

[1] Kayrak, M. *et al*. 2012. Electrocardiographic findings in patients with polycythemia vera. *International Journal of Medical Sciences* 9(1): 93–102. doi: 10.7150/ijms.9.93. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3245418/>.

[2] Jenkins, D. and S. Gerre. *n.d.* Normal ECG [webpage]. *ECG Library*. <https://ecglibrary.com/norm.php>.

[3] Garner, K. and R. Felgar. *n.d.* Case 705: a 49-year-old male with tooth pain (CP-1011) [webpage]. UPMC Department of Pathology. <http://path.upmc.edu/cases/case705.html>.

[4] Lanikova, L., *et al.* 2016. Coexistence of gain-of-function *JAK2* germ line mutations with *JAK2*^{V617F} in polycythemia vera *Blood* 128(18): 2266–70. doi: 10.1182/blood-2016-04-711283. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5095759/>.