

7.3 NEW Wells Score and D-Dimer for Pulmonary Embolism

Recall from problem 3.3 that a pulmonary embolism (PE) is blood clot in the lungs. A PE typically occurs when a blood clot that formed in a leg or pelvic vein breaks off and ends up in the lungs. This can cause shortness of breath, chest pain, low blood pressure, and death.

Assume that computed tomographic pulmonary angiogram (CTPA) is a perfectly accurate test for PE, but we can't obtain a CTPA on every emergency department (ED) patient who has a slight possibility of PE. This is because a CTPA involves ionizing radiation, exposure to intravenous contrast, and ties up an imaging resource that may be needed by other patients. Assume that the risks and harms of a CTPA outweigh the benefit of identifying a PE when the probability of PE < 3% .(1) We will consider two tests to help decide whether to obtain a CTPA on a patient with symptoms possibly suggestive of PE: 1) the simplified Wells Score, and 2) the plasma D-Dimer level, which we met in problem 3.3.

The Wells score stratifies patients into low-, moderate-, and high-risk groups. Here are data on the prevalence of PE in 6013 patients in different Wells Score groups.(2)

Wells Risk Group	Wells score Range	PE+	PE-	Total	P(PE r)
Low	< 2	229	2513	2742	8.4%
Moderate	2-5	586	2220	2806	20.9%
High	> 5	232	233	465	49.9%
		1047	4966	6013	17.4%

D-Dimer appears at higher levels in the blood when the body's clotting system is activated, so higher values are more suggestive of PE. Data from the same 6013 patients fit the interval likelihood ratios (iLRs) in this table surprisingly well.

D-Dimer (ng/ml)	Approximate iLR
< 250	1/16
250 - 499	1/8
500 - 749	1/4
750 - 999	1/2
1000 - 1499	1
1500 - 2499	2
2500-4999	4
≥5000	8

Assume that the Wells Score and the D-Dimer are independent conditional on PE+/PE-.

- a) For patients like those in this dataset, what is the probability of PE in a patient with a low-risk Wells Score and a D-Dimer 750-999 ng/mL?

Answer: The prior odds based on the low-risk Wells score would be $8.4\%/(100\%-8.4\%) = 0.092$. We multiply by the LR of 1/2 to get posterior odds of 0.0456, and posterior probability of $0.0456/1.0456 = 0.0436$.

- b) What if the Wells Score is still low-risk but the D-Dimer is 500-749 ng/mL?

Answer: In this case the post test odds would be $0.092 \times 1/4 = 0.0229$, so post test probability would be $0.0229/1.0229 = 0.0223$

- c) Based on (a) and (b), what is the D-Dimer threshold for getting a CTPA in a patient with a low-risk Wells Score?

Answer: If the D-dimer level is <750 ng/mL and the patient has Wells score in the low-risk group, then the post-test probability of 0.0223 will be less than our 3% threshold for getting a CTPA. If the D-dimer is ≥ 750 ng/mL, then the post test probability will be 4.36%, which is more than our CTPA threshold. So the D-Dimer threshold is 750 ng/ml.

- d) What is the D-Dimer threshold for getting a CTPA in a patient with a moderate-risk Wells Score?

Answer: The moderate risk Wells score gives a pretest probability of 20.9%, so pretest odds of $.209/(1-.209) = 0.264$. If the D-Dimer is 250–499 ng/mL, the LR of 1/8 will get the post-test odds down to $0.264/8 = 0.033$, for a post-test probability of $0.033/1.033 = 3.2\%$. This is not quite below our threshold of 3%, so our D-Dimer threshold will need to be no CTPA if the D-Dimer is <250 ng/ml.

- e) What is the D-Dimer threshold for getting a CTPA in patient with a high-risk Wells Score?

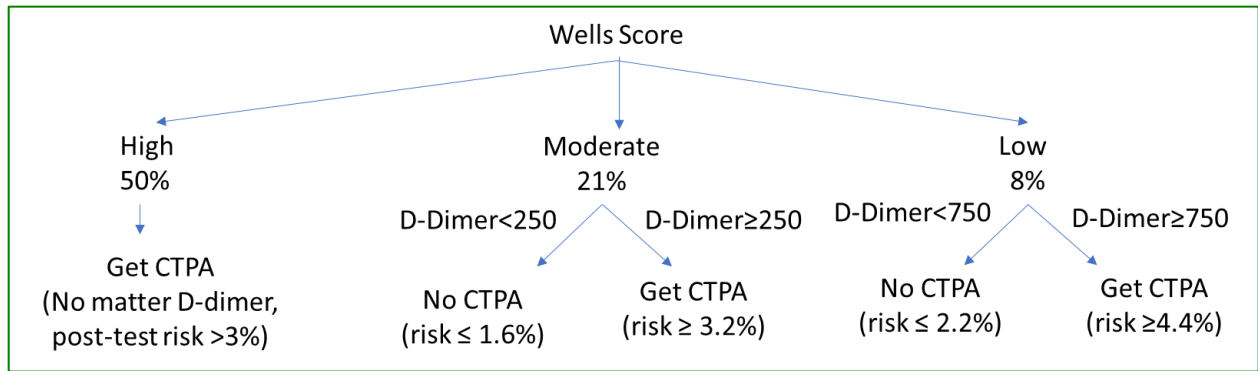
Answer: With a high risk Wells Score, the pretest probability will be 49.9%, so pretest odds will be about 1 and even with the most reassuring D-Dimer level of < 250 with an LR of 1/16, the post-test odds will be 1/16. This corresponds to a posttest probability of $1/17 = 5.9\%$, which is still above our PTCA threshold. So no D-Dimer is reassuring enough to forgo CTPA. (So no need to send it!)

- f) You have just derived a decision rule for obtaining a CTPA in an ED patient with symptoms suggestive of PE that uses Wells Score and D-Dimer level. Summarize the rule in words, a table, or a tree diagram.

Wells Score High Risk? \rightarrow CTPA

Wells Score Moderate Risk? \rightarrow D-Dimer \rightarrow > 250 ? \rightarrow CTPA

Wells Score Low Risk? \rightarrow D-Dimer \rightarrow > 750 ? \rightarrow CTPA



Thanks to Nico Arger for this figure!

1. Lessler AL, Isserman JA, Agarwal R, Palevsky HI, Pines JM. Testing low-risk patients for suspected pulmonary embolism: a decision analysis. *Ann Emerg Med.* 2010;55(4):316-26 e1.
2. Kohn MA, Klok FA, van Es N. D-dimer Interval Likelihood Ratios for Pulmonary Embolism. *Acad Emerg Med.* 2017;24(7):832-7.