3.9.A Diagnosing Peripartum CHF with BNP from 2019 Final

(Thanks to Stephanie Frazin, Elia Rubio, Jessie Grubman)
[15 points]

One of the leading causes of maternal morbidity and mortality in the United States is congestive heart failure (CHF). The incidence of CHF during pregnancy and shortly after delivery (the peripartum period) has consistently risen in the last decade; however, its diagnosis remains challenging. Symptoms of CHF include dyspnea (shortness of breath), fatigue, and lower extremity swelling, which also happen to be common features of normal pregnancy. Echocardiogram (ultrasound of the woman's heart) is a very accurate test for CHF but it is often unavailable, especially in emergent situations.

B-type natriuretic peptide (BNP) is a hormone secreted by the myocardium (muscle of the heart) when the chambers of the heart stretch. It is used in non-pregnant people as a test for CHF, but it hasn't been studied in peripartum women with symptoms suggestive of CHF. BNP is a continuous test.

Malhame et al (2) performed a study to determine the accuracy of BNP in diagnosing heart failure in the peripartum period. The index test was the BNP level and gold standard for peripartum CHF was a consensus diagnosis by two cardiovascular disease experts using echocardiogram and clinical features but blinded to BNP.

The authors reported the sensitivity, specificity, positive and negative LR(+), and LR(-) at multiple possible cutoffs as shown in their Table 3 below. The cutoff of 111 pg/mL was considered "optimal" by the authors because it maximized Youden's Index.

Table 3. Performance of B-Type Natriuretic Peptide in Diagnosing Heart Failure Among Pregnant and Postpartum Women

BNP Cutoff (pg/mL)	Sensitivity (95% CI)	Specificity (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Accuracy (95% CI)	n (%) With BNP Levels at the Threshold or Higher
20	100 (91–100)	29 (11–52)	1.4 (1.1–1.8)	0 (—)	75 (62–85)	54 (90)
50	97 (87–100)	43 (22–66)	1.7 (1.2–2.5)	0.06 (0.01–0.4)	78 (66–88)	50 (83)
100	95 (83–99)	52 (30–74)	2.0 (1.3–3.1)	0.1 (0.02–0.4)	80 (68–89)	47 (78)
111	95 (83–99)	62 (38–82)	2.5 (1.4–4.3)	0.1 (0.02–0.3)	83 (71–92)	45 (75)
150	79 (64–91)	67 (43–85)	2.4 (1.3–4.5)	0.3 (0.2–0.6)	75 (62–85)	38 (63)
200	74 (58–87)	71 (48–89)	2.6 (1.3–5.3)	0.4 (0.2–0.7)	73 (60–84)	35 (58)
300	54 (37–70)	86 (64–97)	3.8 (1.3–11.2)	0.5 (0.4–0.8)	65 (52–77)	24 (40)
500	42 (28–57)	95 (76–100)	5.9 (0.8–42.8)	0.8 (0.6–0.9)	52 (38–65)	12 (20)

BNP, B-type natriuretic peptide.

a. A patient who presents with pretest probability of 30% for peripartum CHF, and is found to have a BNP of 250 pg/mL. Which of the published LRs should you use to calculate post-test probability? [1]

i) 2.6 because 250 > 200
ii) 0.5 because 250 < 300
iii) 2.5 because 250 > 111 (the "optimal" cutoff)
iv) 0.8 because 250 < 500
v) None of the above

Answer: (v). Should be a gimme.

Little is lost by reducing Table 3 above to just 2 rows, the row corresponding to a cutoff of 500 pg/mL and the row corresponding to a cutoff of 100 pg/mL. Ignore the other rows.

To be absolutely clear, here is the **simplified table** we want you to use for the rest of this problem:

BNP Cutoff (pg/mL)	Sensitivity	Specificity
100	95%	52%
500	42%	95%

b. Given the results the **simplified 2-row table** shown above, calculate the post test probability of CHF in the patient from (a) with a BNP of 250 pg/mL [3]

Answer: ***Calculate appropriate interval LR from table above.***
P(BNP 100-500 \| D+)/P(BNP 100-500\|D-)
Using table above: (0.95-0.42)/(0.95-0.52) = 0.53/0.43 = 1.23
Pretest Probability = 30% = 0.30
Convert to Pretest Odds, Pretest Odds = pretest probability/(1- pretest probability) = 0.30/(1-0.30) = 0.43
Posttest odds = pretest odds x LR, 0.43 x 1.23 = 0.53
Now convert to posttest probability, Posttest probability = posttest odds/(1+posttest odds) = 0.53/(1+0.53) = 0.35
The posttest probability for peripartum cardiomyopathy with a pretest probability of 30% and BNP of between 100 and 500 is 0.35.

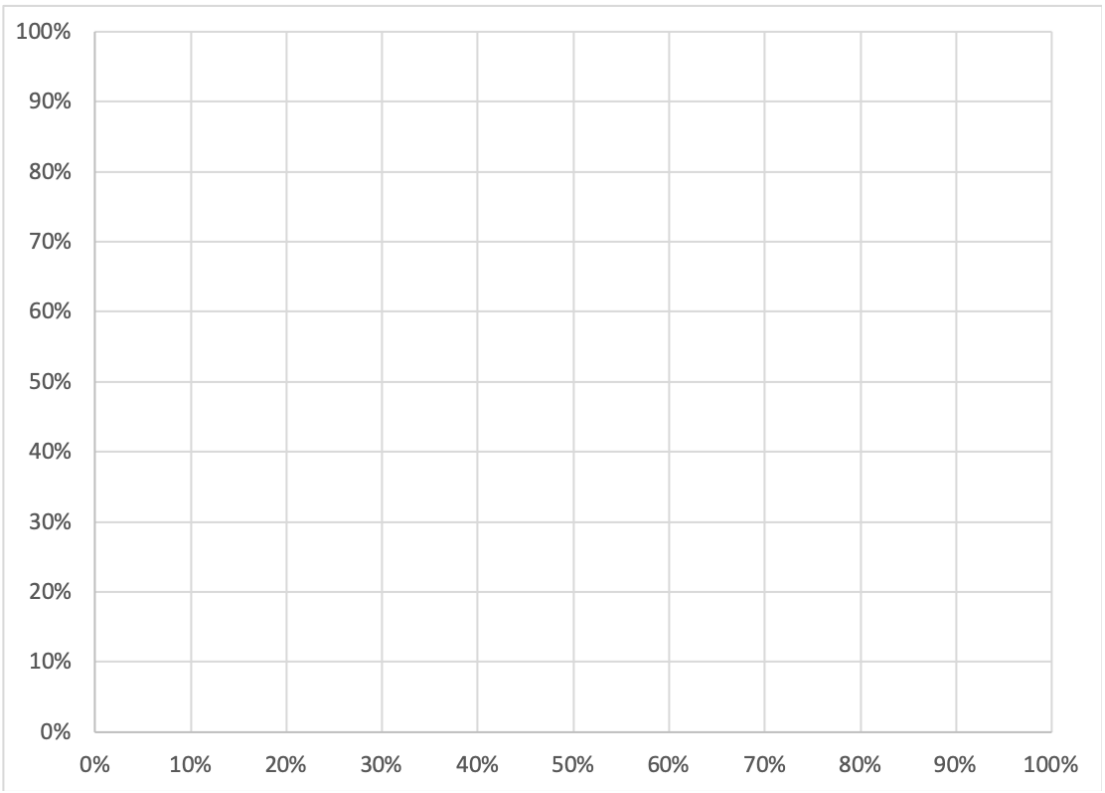
Somebody who hasn't taken Epi 204 decides to treat BNP as a dichotomous test with a cutoff of 500 pg/mL, so this person considers a BNP $\geq$ 500 pg/mL as positive for CHF and a BNP < 500 negative for CHF.

c. Repeat part (b) treating using this dichotomous BNP, i.e. calculate the post-test probability based only on the information that your patient's BNP result is < 500 pg/mL. If you get a different post-test probability from (b), explain why. [3]

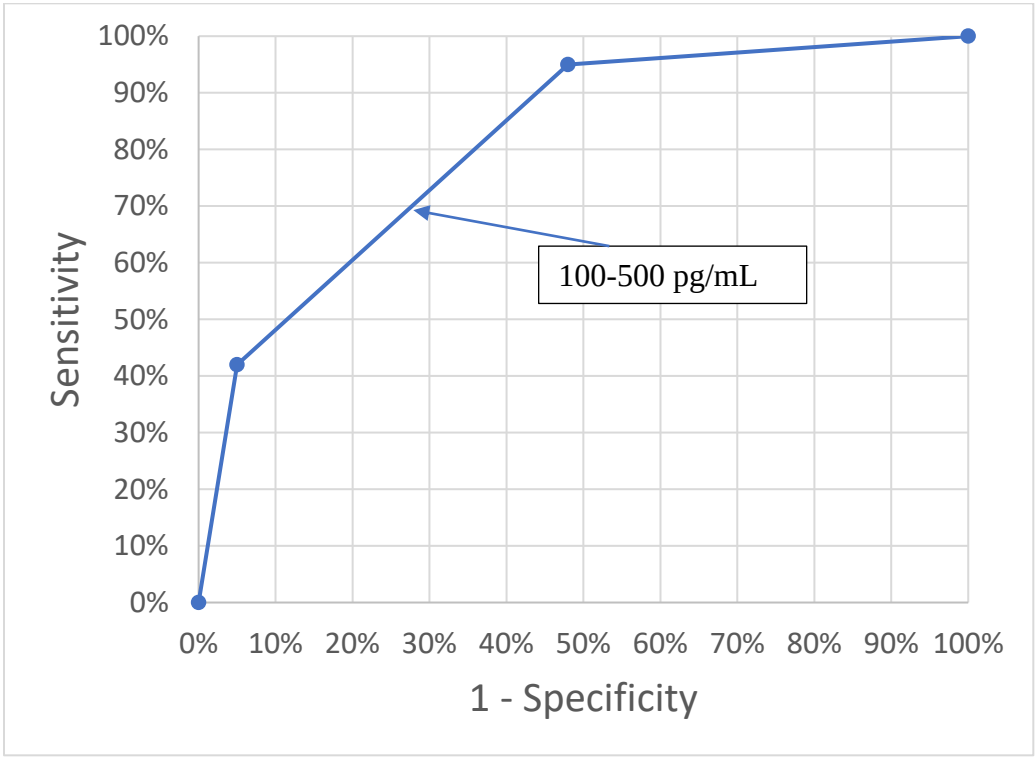
Answer: ***Use LR(-) = 0.8.***
Pretest Probability = 30% = 0.30
Convert to Pretest Odds, Pretest Odds = pretest probability/(1- pretest probability) = 0.30/(1-0.30) = 0.43
Posttest odds = pretest odds x LR, 0.43 x 0.8 = 0.34
Now convert to posttest probability, Posttest probability = posttest odds/(1+posttest odds) = 0.34/(1+0.34) = 0.26
The posttest probability for peripartum cardiomyopathy with a pretest probability of 30% and BNP of < 500 is 0.26.

It's lower than the previous answer because the result of 250 was previously only being lumped together with results between 100 and 500. Now it's also being lumped together with results < 100, so the LR is lower, 0.8 vs. 1.23.

d. Use the data in the **simplified table** above and the grid below to label the axes and plot an ROC curve for BNP as a test for peripartum CHF. If it's easier, feel free to create your own grid rather than use ours. [3]



Answer:



e. Indicate the part of the graph that corresponds to a BNP of 100 to 500**.** [1]

See arrow above.