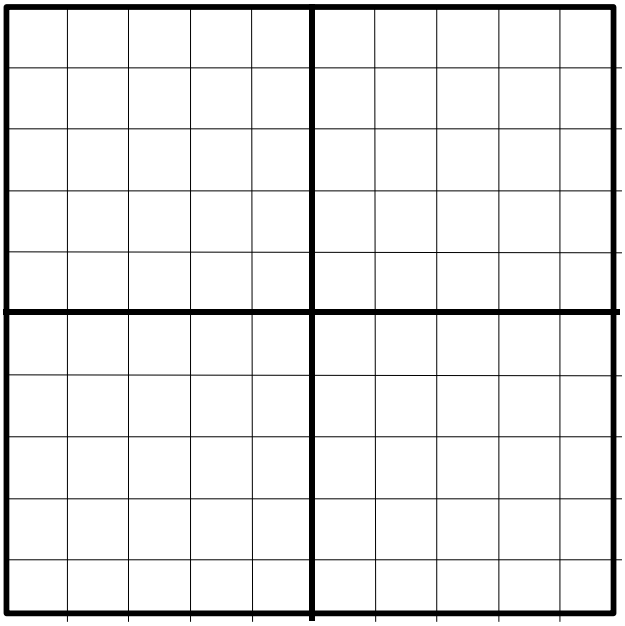
3.2 A Below are some real data on urine white blood cells from urinalyses as a test for urinary tract infection (UTI) of febrile infants < 3 months old.[1, 2] The top number in each cell is the number of infants; the number just below is the column percent. So, for example, 25.21% of the infants with a UTI had 0-2 White Blood Cells per High-Power Field (WBC/HPF).

MICROSCOPIC URINE WBCS	UTI? YES	NO	Total
0-2/HPF	30	857	887
	25.21	83.53	77.47
3-5/HPF	11	94	105
	9.24	9.16	9.17
6-10/HPF	12	43	55
	10.08	4.19	4.80
11-20/HPF	33	19	52
	27.73	1.85	4.54
>20/HPF	33	13	46
	27.73	1.27	4.02
Total	119	1026	1145
	100.00	100.00	100.00

a. Label the axes and draw an ROC curve for this test below.



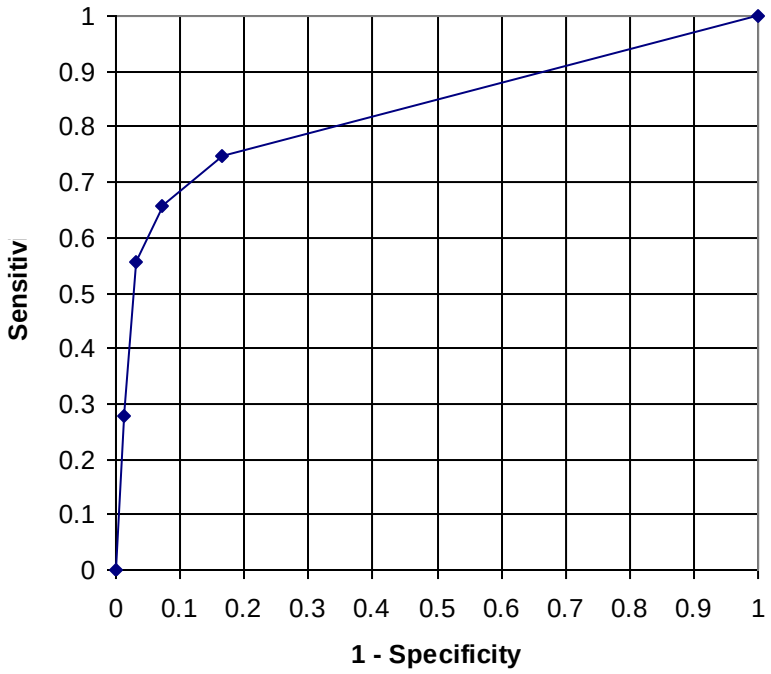
Step 1: Recreate the table, but sort the test results from most abnormal to least abnormal. This is an LR table (with the LRs not calculated).

URINE WBCS	Yes	No
>20/HPF	27.73%	1.27%
11-20/HPF	27.73%	1.85%
6-10/HPF	10.08%	4.19%
3-5/HPF	9.24%	9.16%
0-2/HPF	25.21%	83.53%
Total	**100.0%**	**100.0%**

Step 2: In a new ROC table add a row at the top corresponding to calling every result negative (the point at the origin of the ROC curve where Sensitivity = 0 and Spec = 1.0).
Then add a row at the bottom corresponding to calling every result positive (the point at the upper right corner of the ROC curve where sensitivity =100% and specificity =0%).
Step 3: Change the intervals to thresholds in the far left column of the ROC table. For example, >20 stays the same, but 11-20 becomes >10. Moving down a column, each cell is the sum of the one above it plus the proportion in the corresponding cell in the LR table from Step 1.

	Sensitivity	1-Specificity
	0	0
>20	27.73%	1.27%
>10	55.46%	3.12%
>5	65.55%	7.31%
>2	74.79%	16.47%
≥0	100.00%	100.00%

Step 4: Plot the points.



b) What is the area under it? (You can just estimate it by counting boxes.)

You should get about 17 boxes above the curve, so 83 must therefore be below, and the area is about 0.83. (The exact answer is 0.8291.)

c). What are likelihood ratios for each category of urine WBC?

You were already given the likelihoods in the initial table; you just need to calculate the ratios. If you reorder the rows so they go from highest to lowest the LR's will show the pattern of slopes starting at the origin of the ROC curve.

URINE WBCS	***Yes***	***No***	***LR***

>20/HPF	*27.73%*	*1.27%*	*21.89*
11-20/HPF	*27.73%*	*1.85%*	*14.97*
6-10/HPF	*10.08%*	*4.19%*	*2.41*
3-5/HPF	*9.24%*	*9.16%*	*1.01*
0-2/HPF	*25.21%*	*83.53%*	*0.30*
Total	*100.0%*	*100.0%*	

d) You are seeing a febrile 6-week old who you can assume as the same prior probability of UTI as the infants in this study. If the urine has 11-20 WBC/HPF, what is your best estimate of the posterior probability?

There are (at least) two ways to do this one: a short way and a long way. The short way is simply to look at the table and see that of the 52 infants with 11-20 WBC/HPF, 33 had a UTI, so the posterior probability is 33/52 = 63%.

The long way is to get the pretest probability of disease from the table (119/1145 = 10.4%, convert to odds, multiply by the LR of 14.97, and convert back to probability. Feel free to try it if you need practice.

What we asked you to calculate in this case was the analog of positive predictive value for a multi-level test: P(disease|result). As was the case with dichotomous tests, in order to calculate predictive value simply by going horizontally in the appropriate row of the table you need to make sure that there was cross-sectional sampling; i.e., that the prior probability is reflected in table.

e) In this study the prior probability of UTI in a girl was about 12%. What would the posterior probability be if she had 6-10 WBC/HPF on her urinalysis?

Prior odds = 0.12 / 0.88 = 0.14
Posterior odds = (0.14)(2.41) = 0.33
Posterior probability = 0.33 / 1.33 = 0.25 (25%)

f) Let's suppose you would begin empiric treatment for UTI if the probability were 15% or more. At what prior probability of UTI would you treat regardless of the UWBC result?

What we're looking for is a prior probability of UTI so high that even if the UWBC is maximally reassuring, our post-test odds will remain above our treatment threshold. So the steps are:

1. ***Convert treatment threshold to odds:***

Treatment threshold odds = 0.15 / (1 - 0.15) = 0.176

2. Find the lowest (most reassuring) likelihood ratio (0.30).

3. Divide the treatment threshold (post-test odds at which you would treat) by the most reassuring LR. That will give you the pretest odds, above which, even if the test were most reassuring, you'd remain above the treatment **threshold.**

LR 0.3

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ODDS_____**|**_____**|**_____

0.176 upper limit of prior for testing

treatment threshold

Upper prior odds = Post odds treatment threshold / (LR for 0-2 WBC/HPF)

= 0.176 / 0.3 = 0.59

Upper prior probability = 0.59 / 1.59 = 0.37 (37%).

Therefore if your prior probability is greater than 37% you would treat regardless of the urine WBC result.

References

1. Schroeder AR, Newman TB, Wasserman RC, Finch SA, Pantell RH. Choice of urine collection methods for the diagnosis of urinary tract infection in young, febrile infants. Arch Pediatr Adolesc Med. 2005;159(10):915-22.
2. Newman TB, Bernzweig JA, Takayama JI, Finch SA, Wasserman RC, Pantell RH. Urine testing and urinary tract infections in febrile infants seen in office settings: the Pediatric Research in Office Settings' Febrile Infant Study. Arch Pediatr Adolesc Med. 2002;156(1):44-54.