Screening for Asymptomatic Bacteriuria in Pregnancy: Urinalysis vs Urine Culture

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Background. Asymptomatic bacteriuria is common during pregnancy. Its average prevalence is 6%. It is an important risk factor for acute pyelonephritis, hypertension, preeclampsia, fetal wastage, low birthweight, and prematurity. This study was performed to determine the usefulness of urine microscopy as a substitute for doing a screening urine culture.

Methods. The medical records of all first trimester obstetric visits from 1984 to 1990 were reviewed at a major university. The results of 888 screening urinalyses were recorded and compared with those of subsequent urine cultures.

Results. Fifty-four cultures had growth of a single organism with a bacteria level of at least 1000 organisms per milliliter. In the prediction of a positive culture, the microscopic findings of five or more leukocytes per high-power field (HPF) showed a sensitivity of 94.4% and a specificity of 95.0%.

Conclusions. Physicians should test the urine of all prenatal patients at their first visit and send to the laboratory only those specimens with 5 or more leukocytes per HPF. Using this method, unnecessary screening urine cultures will be substantially reduced.

Key words. Bacteriuria; pregnancy; urine; culture; microscopy. *J Fam Pract 1991; 33:471-474.*

Pregnancy substantially alters the function of the urinary tract[1] and increases the risk of infection, potentially causing maternal and fetal morbidity. Asymptomatic bacteriuria often precedes symptomatic urinary tract infections in pregnant patients.[2] The average prevalence of bacteriuria is 6%, with a range of 2.3% to 17.5% reported in the literature.[3–7] When bacteriuria remains untreated during pregnancy, 30% to 40% of patients will progress to symptomatic pyelonephritis,[1] which is the most frequent cause of antenatal hospital admissions.[8]

Both hypertension and preeclampsia have been reported to occur more frequently in pregnant women with asymptomatic bacteriuria.[9,10] Long-term sequelae, such as chronic pyelonephritis and renal failure, may follow bacteriuria.[11] Other studies have suggested that bacteriuria is associated with a high risk of fetal wastage, dorsal midline fusion defects,[11] low birthweight, and prematurity.[12]

Multiple authors have shown that the treatment of asymptomatic bacteriuria in the first trimester of pregnancy can reduce the incidence of pyelonephritis and possibly the incidence of low birthweight babies.[13–16] Thus, screening for bacteriuria has become a standard component of the prenatal visit.[7] Some clinicians, however, do not screen their pregnant patients. Their reluctance is due to the false belief that the incidence of bacteriuria is low,[3–6] or that screening by urine culture is overly expensive.

In today's cost-conscious environment, it is sensible to limit the use of urine cultures and to substitute less expensive tests when feasible. Urine analysis is a possible substitute for urine culture.[17] In fact, clinical studies show that pyuria is present in 80% to 95% of cases of proven bacteriuria (including those with bacterial colony counts of less than 10,000/mL). Other studies, however, contest the value of pyuria in predicting bacteriuria on the basis of an inadequate specificity of 50% to 76%.[18,19]

The most accurate method of estimating the number of white cells in the urine (pyuria) is to determine the leukocyte excretion rate.[18,19] This method is not practical, however, for routine office use.[18,19] Alternative methods include enumeration of leukocytes using a counting chamber, which has been found to correlate well with the leukocyte excretion rate.[19–22]

The estimation of white blood count (WBC) per high-power field (HPF) is simple, fast, and the most

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commonly used procedure to quantify pyuria in clinical practice. According to previous studies, however, this method lacks precision.[23] Also, considerable differences exist in the recommended pathological threshold values for pyuria, possibly because of uncontrolled variables and technical error.[24–26]

The goal of this study was to evaluate the accuracy in predicting the presence or absence of significant asymptomatic bacteriuria based on the results of pyuria levels determined by simple microscopy.

Materials and Methods

This study was performed in the Family Medical Center at the American University of Beirut, a model residency-faculty practice with 3000 registered patients and 5000 patient visits each year. The charts of all patients in their first trimester of pregnancy who visited the Family Medicine Center between 1984 and 1990 were reviewed. Only patients who were asymptomatic and had no coexisting medical problems at the time of presentation were included in the study.

The results of screening urinalyses were recorded and compared with the results obtained on subsequent urine cultures. All of the specimens were obtained by the "clean-catch" method on the first obstetric visit. Any complications that had developed and had been documented in the patient's chart at the time of the antenatal follow-up, such as pyelonephritis or preterm labor, were noted.

For the purpose of this study, asymptomatic bacteriuria is defined as the presence of ≥1000 colonies of bacteria per milliliter of urine from a specimen obtained by the clean-catch, midstream collection method. The microscopic examination was performed on a urine sample centrifuged at 2000 rpm for approximately 5 minutes. Sensitivity, specificity, and positive-predictive value were calculated to assess the utility of using the WBC to predict the presence or absence of bacteriuria.

Receiver operating characteristic (ROC) curves of leukocyte count by microscopy of urinary sediment were constructed by establishing incremental cutoff points. The selected cutoff points for pyuria were >8 WBC/HPF, ≥5 WBC/HPF, and ≥1 WBC/HPF.

An ROC curve demonstrates the relationship between sensitivity and specificity for various cutoff points on a screening test. Lowering the cutoff point to increase sensitivity inevitably results in increasing the false-positive rate, thus decreasing the specificity. Increasing the cutoff point, however, lowers the false-positive rate, thus decreasing the sensitivity. A test with no diagnostic value would appear as a 45° line through the origin. The typical ROC curve is a smooth, concave curve.

Table 1. Number of Leukocytes per HPF and Results of Concurrent Urine Culture

Leukocyte per HPF	Result of Urine Culture: Positive*	Negative	Total
None	0	555	555
1–4	3	240	243
5–8	12	27	39
>8	39	12	51
Total	54	834	888

**Positive culture is defined as >1000 organisms/mL of a single organism. HPF denotes high-power field.*

Results

The mean age of the patients included in the study was 26.43 years with a standard deviation of 6 years and a range of 15 to 44 years.

Using a level of bacteriuria of 1000 organisms per milliliter as the cutoff point, cultures of 54 (6.08%) of the 888 clean, midstream urine specimens were positive. Positive culture at a colony count of >100,000/mL was 48 (5.4%) for the increasing levels of bacteriuria. Table 1 shows the results determined by leukocyte count per HPF vs urine culture results. Table 2 shows the results of the assessment of the selected levels of leukocyte number per HPF. The sensitivity and specificity of leukocyte level in the prediction of a positive culture and the predictive values of positive and negative tests are shown.

The ROC curve of leukocyte count as a predictor of asymptomatic bacteriuria is shown in Figure 1. Using a leukocyte count of >8 as the cutoff point, the sensitivity was 72%, while the false-positive rate fell to 1%. Figure 1 illustrates that as the sensitivity increases, the false-positive rate increases. When sensitivity was 100%, the false-positive rate was 33%.

Table 2. Prediction of Bacteriuria (>1000 organisms/mL) by Level of Leukocyte Count for Centrifuged Urinary Sediment (n = 888)

Leukocyte Count (WBC/HPF)	Sensitivity	Specificity	Positive-Predictive Value	Negative-Predictive Value
>8	72.2	98.6	76.5	98.2
≥5	94.4	95.3	56.7	99.6
≥1	100	66.6	16.2	100

WBC denotes white blood count; HBF, high-power field.

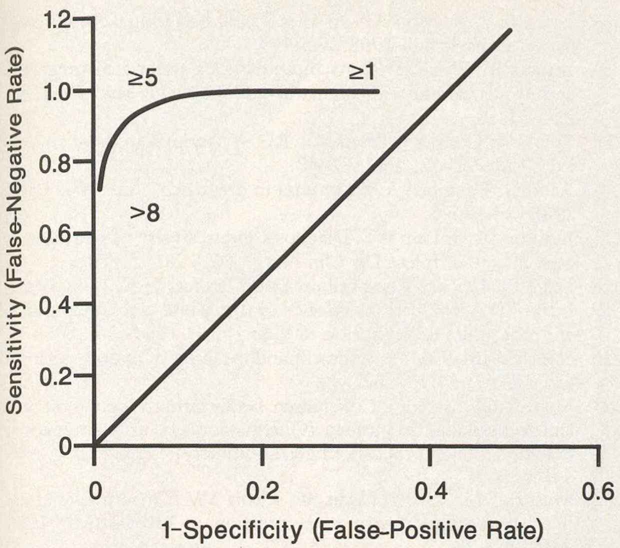

Figure 1. Receiver operator characteristic curve of pyuria in diagnosing asymptomatic bacteriuria.

Discussion

The ideal test for detection of bacteriuria would be inexpensive, quick, accurate, and easy to perform. No currently available test satisfies all of these criteria. Culturing requires special laboratories and special collection procedures, and the cost is substantial. The results are not available for 24 to 48 hours and, if positive, necessitate contacting the patient.

Although an association between pyuria and urinary tract infection has long been recognized, the reliability of urinalysis in diagnosing urinary tract infections is still not uniformly accepted. A previous practice-based study has shown the value of urine microscopy.[27]

Pyuria frequently occurs without bacteriuria.[26] Opinions in the literature differ as to what constitutes "significant" pyuria. According to Little,[19] when the number of WBC/HPF exceeds 5, the white cell excretion rate is greater than 400,000 leukocytes per hour. This forms the basis for considering significant pyuria to be >5 WBC/HPF. In our study we did not define pyuria; rather, we resorted to dividing the number of leukocytes/HPF into five categories: none or rare, 1 to 4, 5 to 8, and >8/HPF.

ROC curves were first used in the 1950s to describe the accuracy of radar operators at distinguishing signals from noise.[28] More recently, it has become apparent that diagnostic tests in medicine have properties analogous to the signal detection paradigm. In determining the actual results of any given test, there is an inevitable trade-off between sensitivity and false-positive rates. The ROC curve describes the performance of the test over the entire range of values. One way to choose the desired cutoff point is to minimize the sum of both false-positive and false-negative test results.

Receiver operating characteristic curves also provide information that is helpful in establishing cutoff points for diagnostic testing. This process is tied to cost-effectiveness. There are benefits in establishing early diagnosis of asymptomatic bacteriuria in pregnancy. The costs of false-positive test results are not high and there are no hazardous, unpleasant, expensive, or invasive diagnostic or treatment modalities. The cost of a false-negative result, however, is high. Therefore, one would select a low cutoff leukocyte count in order not to miss many pregnant women with asymptomatic bacteriuria.

To avoid missing even a single urinary tract infection, the recommendation would be to screen all patients with microscopy and to send those with >1 WBC/HPF for urine culture. To minimize unnecessary health care expenditures, however, the best policy is to use 5 WBC/HPF as the cutoff for significant pyuria. The sensitivity and specificity of the test are highly acceptable, leading to falsely treating only 39 patients, while missing only 3 infected patients; a failure rate that is no worse than that for most laboratory culture methods.

An advantage of microscopic urine analysis is that it can be performed while the patient is in the clinic, and treatment can be initiated immediately if indicated. Obviously, false-positive results would lead to unnecessary treatment (39 patients in our study) but false-negative results are of even greater concern (3 patients in our study).

To calculate both sensitivity and specificity, it is necessary to have a reference standard to determine whether a person has or is free of the disease in question. The choice of a reference standard is a special problem with urinary tract infections. The colony count that has traditionally been accepted as indicating a urinary tract infection is 100,000/mL of urine. As indicated by Ferry et al,[29] this standard was derived from studies of pyelonephritis. More recent work has indicated that colony counts as low as 100/mL may indicate infection in women with dysuria.[30]

To maximize the information derived from the urinalysis and to minimize the error inherent in the measurement of pyuria, the urine collection should be done in midstream. Prompt examination of freshly voided urine will increase the likelihood of correctly predicting the presence or absence of a treatable infection.[31] If careful attention is paid to the initial specimen volume, the resuspension volume, the centrifugation time and speed, and the counting technique, then the HPF enumeration method can be made more accurate.[23]

Performing a screening urinalysis appears to be especially important during pregnancy, when there is strong evidence that treatment is efficacious. Identification and appropriate treatment and follow-up of pregnant patients with asymptomatic bacteriuria can virtually eliminate symptomatic pyelonephritis. A microscopic urinalysis should be the initial screening test for the new obstetric patient.

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For editorial comment, see page 453.