Pyuria Detection Using A Dipstick Applied to Urine In Incontinence Pads

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The purpose of this study was to determine whether pressing a dipstick into a pad within 2 hours of urine saturation detected pyuria as effectively as immersing a dipstick in a urine specimen. Sensitivity, specificity, and positive and negative predictive values indicated that results of the pad method were as effective as those of direct dipstick into clean-catch urine in detecting pyuria. In the elderly, sensitivity of the pad method was 100%, indicating this would be an effective method for initial assessment of pyuria.

Introduction

Determination of pyuria in incontinent elderly individuals by dipstick applied to incontinence pads could eliminate unnecessary testing and facilitate the rate at which persons receive early nursing interventions for potential UTIs.

Method

Clean catch urine was collected in a "hat." Within an hour post-void, some of the specimen was analyzed microscopically for WBCs by a clinical laboratory scientist to serve as the gold standard for accuracy for all dipstick results. A Chemstrip 10® dipstick was used by a research nurse to check for the presence of leukocyte esterase, by dipping it directly into the obtained specimen. Urine was then poured into an incontinence pad and a Chemstrip 10 was pressed into the urine-soaked pads immediately. A Chemstrip 10 was again, pressed into the pad urine after 2 hours.

Results

When compared to laboratory microscopy, sensitivity, specificity, and positive and negative predictive values indicated that dipstick results of the pad method, both initially and at 2 hours, were as effective as those of a dipstick immersed in the urine specimen. Over half of all positive results were false, though, and would require further evaluation. However, in those greater than 65 years old, all individuals with pyuria were correctly identified and all negative results indicated a lack of pyuria using any of the three dipstick methods.

Conclusions

There is a lack of consensus among health care professionals about what constitutes a UTI in an elderly individual. If pyuria is required for a UTI to be present in this population, then negative results of a dipstick pressed into an incontinence pad within 2 hours of urine saturation would be a good indication of the absence of a UTI. Positive results, however, would require further analysis, as over half of these outcomes were false. "The value of a positive test should be judged not on its ability to detect UTIs but on the additional information it provides in evaluating the clinical picture" (White & Kunin, 1993, p. 230). Further studies may find positive results of the dipstick/pad method combined with other clinical findings could aide in the decision to send urine for laboratory analysis. Positive results may also help provide additional information to the clinical picture and help in managing UTIs in the elderly. The dipstick/pad method could be used in the initial assessment of an incontinent individual who may have difficulty giving a urine specimen on-site at the nursing home where laboratory facilities may be lacking.

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infection and a need for further laboratory analysis (Norman, Yamamura, & Yoshikawa, 1986; Pfaffer, Ringenberg, Rames, Hegeman, & Koontz, 1987; Stamm, 1983; Wigton et al., 1985). The level of pyuria may indicate an infection’s virulence (Nicolle, 2001). Pyuria has also been associated with a lower long-term survival rate among the elderly (Heinamaki, Haavisto, Hakulinen, Mattila, & Rajala, 1986). Assessing pyuria in the elderly nursing home population, therefore, may be an important factor in identifying UTIs and improving outcomes in this population.

In the laboratory, the traditional setting of pyuria analysis, dipstick assessment of leukocyte esterase is used to initially screen urine specimens for this condition. “Leukocyte esterase, an enzyme present in WBCs, reacts with a reagent impregnated into the dipstick pad producing a blue color...” (Pappas, 1991, p. 315). Unfortunately, the nursing home may not have laboratory facilities readily available (Ouslander, 1989). This may lead to a delay in diagnosis, a factor leading to poorer outcomes in the elderly.

There are other difficulties in assessing elderly individuals for UTIs. Urine specimens can be difficult to obtain, especially in the incontinent elderly. Urine in pads, however, may afford an alternative to clean-catch or midstream specimens for evaluating bacteriuria and pyuria. Studies of urine extracted from pads that do not contain gel have found bacteriuria detection similar to that of traditional urine specimens (Ahmad, Vickers, Campbell, Coulthard, & Pedler, 1991; Cohen et al., 1997; Vernon, Redfern, Pedlar, Lambert, & Coulthard, 1994). These studies also found reduced WBC counts compared to conventional urine specimens, leading to the hypothesis that pad material retains or breaks apart WBCs. Although WBCs may be affected by pad urine, leukocyte esterase may not. One study found that while WBCs may be retained in the pad and unavailable for microscopy, soluble leukocyte esterase from pad urine could be detected by a test strip (Macfarlane, Houghton, & Hughes, 1999).

Incontinence pads are often monitored every 2 hours. If leukocyte esterase results from a dipstick pressed into pad urine within a 2-hour time frame are similar to leukocyte results from a dipstick immersed in a urine specimen, the former would afford an easy, quick, and inexpensive alternative method for initially assessing pyuria. This method could be used at nursing homes and offer useful, objective data for the residents’ clinical picture.

Purpose

The aim of this study was to compare leukocyte esterase results from a urine dipstick pressed into a pad within 2 hours of urine saturation to results obtained from a urine dipstick immersed in a clean-catch urine specimen for the purpose of detecting pyuria.

Method

Sample. A convenience sample was taken from clinic patients and staff and eldercare and nursing home residents who met the following criteria: they were at least 18 years old, able to give informed consent, and antibiotic-free 7 days before the study. No other history was taken. Most clinic patients included in the study had a urinalysis ordered. Reasons for the urinalysis included ruling out UTIs or post-UTI treatment, as well as a need to perform tests due to employment physicals, pregnancy, or diabetic screening. Informed consent was obtained. Procedures conformed to the University of North Dakota’s Institutional Review Board’s ethical guidelines.

Procedure. Participants were instructed in a clean-catch technique. Urine specimens were collected from a new “hat” placed in the toilet. A minimum of 30 ml was required to be included in the analysis. A time limit of 1 hour post-voiding was imposed on the dipstick urinalysis of the clean-catch specimen, the initial dipstick pad test, and the WBC microscopy. Urine specimens meeting the study criteria were tested in the following manner: A dipstick was immersed in the urine specimen and leukocyte esterase results were read according to manufacturer’s guidelines (dipstick/ua). After removing enough urine for microscopic analysis, a portion of the specimen sufficient to wet the pad was poured into a middle section of a Dry Comfort® incontinence pad (SCA Hygiene, Eddystone, PA). The principal components of the pad are wood pulp and a superabsorbent polymer. The upper portion of a urine dipstick, Chemstrip 10 with SG®, containing test sections for specific gravity and leukocyte esterase, was pressed into the wettest part of the pad with a minimum of 10 seconds. Results were read according to manufacturer’s guidelines (dipstick/pad 0h). Two hours after voiding (plus or minus 15 minutes), a urine dipstick was pressed for 10 seconds into a wet section of the pad that had not been used for the initial dipstick test. Results were read using the same guidelines (dipstick/pad 2h). To insure that negative results were not due to an insufficient amount of urine coming in contact with the leukocyte esterase test section, a color change in the specific gravity test section was also required. The leukocyte esterase results of

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all three methods were read as negative, trace, 1+, and 2+. Negative and trace results were considered negative (neg), and 1+ and 2+ were considered positive (pos).

The gold standard was determined by urine microscopy performed in the following manner: Five ml of the urine specimen were centrifuged for 5 minutes at 400x g. Four and one-half ml of the supernatant were removed and the sediment was suspended in the remaining half ml sample. A drop of this suspension was placed on a slide and viewed under 450x light microscopy. White blood cell results of < 10 were considered negative and those ≥ 10 were considered positive. This designation conforms to the “CDC definition for nosocomial infection, 1988” classification of pyuria indicative of a UTI (Garner, Jarvis, Emori, Horan, & Hughes, 1988).

Analyses. Results of each dipstick method were compared to the gold standard. These were designated true positive for the method if the dipstick and microscopy were both positive; true negative if the dipstick and microscopy were both negative; false positive if the dipstick was positive but the microscopy was negative; and false negative if the dipstick was negative but the microscopy was positive. To compare the three dipstick methods — dipstick/ua, dipstick/pad 0h, and dipstick/pad 2h — several analyses were then performed: sensitivity, specificity, positive and negative predictive value, and efficiency.

Sensitivity is the percentage of specimens positive for pyuria that the method correctly identifies as positive. “Tests with high sensitivity (> 99%) can be used to exclude the presence of disease” (Weissfeld et al., 1998, p. 61). Negative predictive value (NPV) is the percentage of negative results of all negative results and “measures the probability that a negative result indicates the absence of disease” (Weissfeld et al., 1998, p. 61). They are calculated in Figure 3.

Efficiency is the “percentage of test results that are correctly identified by the test” (Weissfeld et al., 1998, p. 61). This is shown in Figure 4.

Results
Consent for participation in the study was obtained from 581 individuals. Of these, 114 were removed from the study for reasons that included insufficient urine, greater than 1 hour elapsed before the specimen could be tested, or urine contained squamous cells in a sufficient number (too numerous to count) to interfere with a WBC microscopy result. Of the remaining 467 participants, 133 (28.5%) were male and 334 (71.5%) were female. The age range was 18 to 95, with a mean age of 51.2 years (+ SD 20.3). Positive WBC results were found in 41 (8.8%) individuals.

Table 1 reports the results of the three methods. Sensitivity indicates the number of individuals with the condition who were correctly identified (Dawson-Saunders & Trapp, 1994). All three methods effectively identi-
fied individuals with pyuria (97.6%). Specificity indicates the number of individuals without the condition that were correctly identified (Dawson-Saunders & Trapp, 1994). Results for all three methods were similar, ranging from 84% to 86.9%.

Positive predictive value (the percentage of patients with a positive test result who actually have the condition) take into account the prevalence of the condition in the study population (Norman et al., 1986; Weissfeld et al., 1998). The PPV varied slightly among the three methods, none achieving more than 42%. For all methods, the NPV was 99.7%; almost all individuals testing negative did not have pyuria. Efficiency measures the number of individuals both with and without the condition who were correctly identified compared to the total sample. Again, the dipstick/pad 2h method was slightly better than the other two methods, identifying almost 90% of individuals correctly. In other words, the dipstick/pad method initially and at 2 hours was as effective as the traditional dipstick urinalysis in pyuria assessment.

The analyses used in this study are influenced by the prevalence of the condition in the population (Lachs et al.,

<table>
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<tr>
<th>Microscopy Results</th>
<th>Dipstick/UA Results</th>
<th>Dipstick/Pad 0h Results</th>
<th>Dipstick/Pad 2h Results</th>
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Dipstick/ua: Sensitivity 97.6%; Specificity 84.3%; PPV 37.4%; NPV 99.7%; Efficiency 85.4%

Dipstick/pad 0h: Sensitivity 97.6%; Specificity 84%; PPV 37%; NPV 99.7%; Efficiency 85.2%

Dipstick/pad 2h: Sensitivity 97.6%; Specificity 86.9%; PPV 41.7%; NPV 99.7%; Efficiency 88%

PPV = Positive Predictive Value
NPV = Negative Predictive Value
Discussion

Comparing Tables 1 and 2, using any of the three methods, all older adults with pyuria were correctly identified. In other words, there were no false negatives (sensitivity = 100%). As all negative results were indicative of urine without WBCs, the NPV was 100% for the elderly. However, the number of false-positive compared to true-negative results increased in all methods (see Table 2), with the greatest increase occurring in the two pad methods. This decreased specificity. Interestingly, the PPV increased in all three methods, perhaps due to the increased prevalence of pyuria in this population. Sensitivities of other studies of leukocyte esterase detection for pyuria using urine specimens have ranged from 36% to 100%, with specificities from 71.4% to 94.3% (Christenson, Tucker, & Allen, 1985; Edwards, van der Voort, Newcombe, Thayer, & Jones, 1997; Herlihy et al., 1984; Zaman et al., 1998). If > 5 WBCs were determined to be in the positive range, some of the initial false positives (the 1+ leukocyte esterase dipstick results of urines with 5 to 9 WBCs) would now be true positives. This would improve the PPV and specificity. However, decreasing the number of WBCs considered to be positive would also mean some of the initial true negative results (negative or trace leukocyte esterase results with urines of 5 to 9 WBCs) would now be false negatives. This would decrease the NPV and sensitivity. A similar manipulation could be performed by considering trace leukocyte esterase results as positive.

It may initially appear that the PPV is the most important factor of this type of test, a positive value indicating a positive result. However, in this setting, sensitivity and NPV are the more important in that, though there were many false-positive results, no true positives were missed in those > 65 years old (no false negatives). Although some individuals without infection were falsely identified as pyuric, no infected elderly individuals failed to be identified; therefore, this test has the potential to be used to screen urines. Further evaluation would be needed for positive individuals because of the number of false-positive results. All negative leukocyte esterase dipstick/pad results were true negative. Therefore, if pyuria is required for a diagnosis of a UTI, as is often the case, a negative dipstick/pad result would be a good predictor that a UTI was not present and further analysis would not be necessary.

Limitations

Analyses used in this study are dependent on the sample studied. Results of the incontinent, nursing home elderly (who have a higher incidence of pyuria) would differ. Methods pertaining to WBC and dipstick analysis may affect the results as well.

Commercial pads comprise various materials which may affect leukocyte esterase results differently (Edwards et al., 1997). Other brands of urine dipsticks use different scales, and thus may result in different findings as well.

Although the dipstick/pad method is easy to use, leukocyte esterase results of some urines fall between the positive (1+) and negative (trace) color of the Chemstrip® color chart and require expertise to interpret correctly. Additional studies using this method will be needed to resolve this problem.

Conclusions

In those > 18 years, the dipstick/pad method, both initially and at 2 hours, was as effective as the dipstick/ua method in assessing pyuria. The dipstick/pad 2h was the most effective for reasons that are not apparent. Among the elderly with a greater incidence of pyuria, the sensitivity, PPV, and NPV of all three methods improved. The frequency of false positives in the elderly increased, more so with the two dipstick/pad methods, decreasing specificity. Even so, the dipstick/pad 2h was as specific as the dipstick/ua and as effective in predicting positive results. This study indicates that leukocyte esterase results of a dipstick pressed into a pad within 2 hours of voiding are as effective as the traditional dipstick/ua method for pyuria detection.

Nursing Implications

A perfect test for a disease would be inexpensive, fast, and easy to use with no possibility of
reader variability. Positive results would always indicate that the condition was present, and negative ones would indicate its absence. Interventions using the test would always be appropriate for all individuals. In the present application, there is an added difficulty independent of the test itself. That is, there is a lack of consensus among health care professionals regarding not only what constitutes a UTI in an older adult, but what actions have positive, long-term benefits for the patient and the population in general (for example, not increasing antibiotic-resistant stains of bacteria). Given these caveats, further studies may find the dipstick/pad method of pyuria identification beneficial to the incontinent nursing home population in several ways.

If pyuria is an indicator of poorer outcomes in incontinent nursing home older adults, the dipstick/pad method could be used to screen for this condition. At present this is not recommended. In this study, a negative result was 100% predictive of a lack of pyuria. Although no test is always correct, a negative result from the pad method would be fairly indicative of apyuria. If apyuria is indicative of no UTI, then a negative LE dipstick/pad result within 2 hours of urine saturation would be reasonably indicative of the absence of a UTI.

All individuals with pyuria in this study were identified by positive dipstick/pad leukocyte esterase. However, there were a substantial number of false positives, and, even with true positive results, there are reasons other than a UTI for an inflammatory response (White & Kunin, 1993). Therefore, “the value of a positive test should be judged not on its ability to detect UTIs but on the additional information it provides in evaluating the clinical picture” (White & Kunin, 1993, p. 230). Leukocyte esterase results are frequently used in combination with other results (Edwards et al., 1997). In addition to a positive leukocyte esterase result, a positive dipstick nitrite test, acute onset of UTI symptoms, and/or a decline in ADLs (analyses that are available to the nurse at the point of care) would add credibility to the possibility of a UTI and need for laboratory analysis.

The importance of the dipstick/pad method for pyuria detection will vary among individuals. Studies may show that some elderly who have continually positive results do not benefit from analysis. Instead, a positive result may be more helpful when seen in the context of a change from a previous negative result.

The dipstick/pad method is as effective as the dipstick/ua method for assessing pyuria. Further studies will determine this method’s effectiveness for improving outcomes among incontinent older adults.

References


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