Using Reagent Strips for Rapid Diagnosis of Peritonitis in Peritoneal Dialysis Patients

Seong-Joo Park, Joon-Yeop Lee, Woo-Taek Tak, Jeong-Ho Lee

Introduction

Despite the advances that have been made in peritoneal dialysis (PD), peritonitis remains a common complication (1). Repeated episodes of peritonitis can accelerate the loss of residual renal function (2), which in turn can contribute to progressive peritoneal membrane failure (3) and the inability to achieve small-solute clearance and adequate ultrafiltration. Early diagnosis and appropriate treatment of peritonitis are important for preventing relapse and peritonitis-associated complications; but, in the early stage of a peritonitis, the effluent fluid may be clear, and clinical signs can be absent.

Several reports have examined the utility of leukocyte esterase reagent strips to detect peritonitis in PD patients (4–7). However, the studied strips showed low sensitivity and various negative predictive values. The present prospective study was performed to examine the utility of a new reagent strip as compared with the standard laboratory methods for evaluating peritonitis in patients on PD.

Patients and methods

Subjects

Our study was performed over a 12-month period in a single renal unit, and it potentially involved 54 patients who received PD during that period. The 54 patients included 31 men and 23 women whose mean age was 55.4 ± 11.8 years (range: 28 – 79 years). In 23 patients, end-stage renal disease was secondary to diabetes; in 11 patients, it was secondary to hypertension; in 9, to chronic glomerulonephritis; in 3, to polycystic kidney disease; in 1, to lupus nephritis; in 1, to neurogenic bladder; and in 6, to unknown causes. The patients had been treated with continuous ambulatory PD and continuous PD for periods ranging from 1 month to 10.5 years.

Laboratory methods

As a negative control, we collected 30 samples of spent peritoneal dialysate from PD patients who were peritonitis-free. Only dialysate samples from patients who were suspected of having peritonitis were tested by laboratory analysis. That analysis included culture of the PD effluent, a white blood cell (WBC) count, and a neutrophil count. The PD effluent was cultured using standard methods to determine the...
organisms responsible for peritonitis and the sensitivity of those organisms to antibiotics.

Peritonitis
Diagnosis of peritonitis was made in the presence of two or more of these signs: clinical symptoms of peritoneal inflammation (abdominal pain, cloudy dialysate); a peritoneal dialysis effluent leukocyte count greater than 100 cells/mm³, with neutrophils constituting more than 50% of all leukocytes; and organisms isolated by Gram stain or a subsequent culture of PD effluent (8,9). The peritonitis was treated according to the sensitivity test results.

Reagent strip
In patients on PD with peritonitis, peritoneal leukocyte esterase is elevated and is associated with an increased neutrophil count. We collected samples of peritoneal dialysate effluent in clean container. We then immersed the reagent strip in the effluent and read it at 4 minutes according to a visual scale. The test-strip color indicated the presence or absence of leukocyte esterase, graded as negative, trace, small, or large. We considered reagent strips showing a result of “trace” or more to indicate peritonitis.

Results
Table I shows the raw data for the reagent strip results, for visual clarity of the effluent, and for WBC counts in patients with and without peritonitis. We diagnosed 19 episodes of peritonitis by the presence of at least two of the three criteria outlined earlier. One patient had 2 episodes of peritonitis during the study period.

In all patients without peritonitis, the visual clarity of the PD effluent was clear. In the patients with peritonitis, visual clarity was cloudy in 16 cases, but clear in 3 cases. The reagent strips gave readings of trace or more for all but one of the samples from patients with peritonitis. A patient with vague abdominal pain had a false negative test strip reading with clear peritoneal effluent and an absolute peritoneal effluent leukocyte count of 105 cells/mm³ (68% neutrophils) without any bacteriologic evidence of peritonitis.

The test strips showed a sensitivity of 100%, a specificity of 97%, a positive predictive value of 95%, and a negative predictive value of 100%. The strip tests had high sensitivity and specificity (Table 2).

Discussion
The results of our study showed that use of a reagent strip to analyze PD effluent is a useful and rapid screening test for peritonitis in PD patients who present with suggestive signs and symptoms.

Peritonitis is a major problem for many PD patients (10). In rural areas, PD patients may live a substantial distance from their dialysis unit. These patients are inconvenienced every time peritonitis is suspected. It would be helpful if such patients could be provided with a simple home test that could aid in the diagnosis of peritonitis.

Diagnosis of peritonitis in the symptomatic patient with cloudy dialysate presents few problems. Exclusion of peritonitis in the patient with symptoms but with clear dialysate, or in the patient with suspicious-looking dialysate but little in the way of symptoms, is less straightforward. Farmer et al. (11) demonstrated that 8 of 127 (6%) peritoneal effluent samples were cloudy without any evidence of peritonitis. Some of those instances were thought to be attributable to chylous ascites. In the same study, 12 of 73 cases (16%) had apparently clear peritoneal effluent despite the presence of peritonitis. In the present study, 3 of 19 peritoneal dialysate samples were clear despite the presence of peritonitis.

In the past, several studies that used the Cytur-Test (Boehringer Mannheim, Mannheim, Germany) reported low sensitivity and varying negative predictive values (6,9,12). More recently, a different leukocyte esterase strip test (PeriScreen Test Strip: Serim Research, Elkhart, IN, U.S.A.) has been developed.

<table>
<thead>
<tr>
<th>Visual clarity</th>
<th>Leukocyte esterase</th>
<th>Laboratory (WBCs/mm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloudy</td>
<td>Clear</td>
<td>Positive</td>
</tr>
<tr>
<td>No peritonitis</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

WBC = white blood cells.

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
</tr>
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<tbody>
<tr>
<td>100%</td>
<td>97%</td>
<td>95%</td>
<td>100%</td>
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TABLE I Clinical, laboratory, and reagent test strip results

TABLE II The sensitivity, specificity, positive predictive value, and negative predictive value of the reagent test strip results
This test uses phenyl pyrrole as the substrate, which is hydrolyzed to an intermediate product that reacts with a diazonium salt to produce a purple color. (The Cytur-Test is impregnated with an indoxyl ester that is oxidized to the blue compound indigo.) Preliminary results for the new strip from a European study showed a sensitivity of 100% and a specificity of 96%, together with an ability to detect as few as 50 leukocytes/mm³ (11). In our study, the PeriScreen Test Strip could detect as few as 100 leukocytes/mm³ (with a neutrophil count of not less than 50%). The results of the present study were achieved with 100% sensitivity and 97% specificity, with a positive predictive value of 95% and a negative predictive value of 100%.

It should be noted that, in addition to neutrophils, the leukocyte esterase–containing granulocytes encompass the eosinophils and basophils (13). Whether the large number of eosinophils present in peritoneal effluent during eosinophilia can also elicit positive esterase strip results remains to be determined.

Conclusions

The new reagent strip that we used for testing PD effluent is a sensitive and specific method for diagnosing PD peritonitis. It can be used as a simple bedside screening test whenever peritonitis is suspected. A positive result should mean the start of empirical antibiotic therapy, and a negative result should exclude peritonitis.

References


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