Peritoneal Fluid Analysis and Result Interpretation: Implications for Nursing Care

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Outline

- Peritonitis
- Non-infectious causes of cloudy dialysate

Diagnosis of PD-Related Peritonitis

Two or more of the following criteria must be present:

1. Abdominal pain
2. Cloudy dialysis effluent with WBC >100 cells/mm³ (usually > 50% are PMNs)
3. Positive culture from dialysis effluent

Vas, 1993
A Word About the Cell Count

- Cell count is dependent on the quantity of fluid in the abdomen and the dwell time
- Dry abdomen – monocyte predominant cell count
- Short dwells may not have time to mount a cell count (i.e. APD presenting at night)
  - Differential will be very helpful here
- An appropriate dwell time is usually ≥ 2 hours
- A cell count of 600 with 95% monocytes is less concerning for peritonitis than a cell count of 89 with 90% neutrophils

Courtesy Dr. Jeff Perl

Gram Stain in the Diagnosis of Peritonitis

- Often negative
- However, may indicate yeast, which allows for rapid catheter removal
- Otherwise, don’t rely on Gram stain for initial antibiotic coverage.

Peritonitis

PD patients presenting with abdominal pain with no clear cause should be presumed to have peritonitis until proven otherwise.

Courtesy Dr. Jeff Perl
Noninfectious Causes of Cloudy Dialysate

• Cellular
  - Polymorphonuclear leukocytes
  - Eosinophils
  - Monocytes
  - Red blood cells
  - Malignant (atypical) cells

• Non-cellular
  - Fibrin
  - Triglycerides

Polymorphonuclear Leukocytes - 1

• Intraperitoneal visceral inflammation
  - Cholecystitis
  - Appendicitis
  - Ischemic bowel
  - Hernia
  - Bowel obstruction
  - Peptic ulcer disease

• Juxtaperitoneal inflammation
  - Visceral (e.g. pancreatitis, splenic infarction, renal cell carcinoma)
  - Abscess

Polymorphonuclear Leukocytes - 2

• Acute Sterile Peritonitis
  - Abrupt onset of abdominal pain, fever and/or chills, cloudy dialysate
  - PMNs in fluid with negative gram stain and cultures
  - Usually resolves in hours with continued PD without antibiotics (4 of 6 patients)
  - Usually occurs in patients with prior documented peritonitis
  - Presumed secondary to rupture of a sterile intraperitoneal abscess

Rocklin and Teitelbaum Sem Dial 14: 37, 2001

Polymorphonuclear Leukocytes - 3

- Drug-associated (e.g. amphotericin, vancomycin)
- Contaminated PD fluid
  - acetaldehyde (GDP)
  - endotoxin - concentrations may be less than the accepted cutoff of 0.5 EU/ml.

Case # 651297

- 68 y/o woman starts CAPD b/o ESRD 2/2 ADPKD
- 4 weeks later c/o cloudy dialysate. No pain, fever etc.
- WBC 427
  - Polys 14%
  - Lymphs 7
  - Eos 37
  - Monos 40
  - Basos 1
  - Meso 1
- Culture negative
- What is the diagnosis? What is the cause?

Causes of Eosinophils in Dialysate

- Eosinophilic Peritonitis
  - Occurs in up to 40% of patients at some point in their course; most common shortly after initiation of PD
  - Often associated with abdominal discomfort; fever is uncommon
  - Total peritoneal WBC < 2000/ mm³; 10-95% eosinophils
  - Remits spontaneously
  - May be episodic in nature for up to 6 months
  - Occasionally associated with peripheral eosinophilia
**Relationship of Peritoneal Eosinophils to Length of Time on Peritoneal Dialysis**

<table>
<thead>
<tr>
<th>Dialysis time (months)</th>
<th>Number of patients</th>
<th>Months of dialysis per patient</th>
<th>% peritoneal eosinophils/mm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>44</td>
<td>1.9 ± 0.05</td>
<td>18 ± 2</td>
</tr>
<tr>
<td>3-6</td>
<td>32</td>
<td>4.9 ± 0.2</td>
<td>10 ± 2*</td>
</tr>
<tr>
<td>&gt;6</td>
<td>25</td>
<td>21.3 ± 2.6</td>
<td>3 ± 4**</td>
</tr>
</tbody>
</table>

Piraino et al. Am J Nephrol. 4: 152, 1984

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**Eosinophils- 2**

Peritoneal eosinophils may represent an allergic response to:

- Sterilant or plasticizer leached from bags, lines, or catheter itself
- Air introduced at the time of PD catheter placement
  - Pleural space responds to the presence of air with eosinophils

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**Sequential Peritoneal Fluid Cell Counts after IP Instillation of 100 cc of Air**

Sequential Peritoneal Fluid Cell Counts after IP Instillation of 500 cc of Air

Eosinophils- 3

Other causes of peritoneal eosinophilia include:

- Blood- e.g. retrograde menstruation
- Drugs- e.g. amphotericin, cephalosporins, chloramphenicol, gentamicin, streptokinase, vancomycin
- Fungal infection- Aspergillus niger

Causes of Monocytes in Dialysate

- In association with eosinophils
- Unrecognized TB
- Icodextrin
  - Numerous cases of “sterile peritonitis” characterized by monocytosis reported, with a peak in the spring of 2002
  - Determined to be due to a peptidoglycan produced by Alicyclobacillus acidocaldarius contaminating raw material from one of the two suppliers thereof
  - Cases essentially ceased once problem rectified

Monocytes- 2

- Other Causes of Cloudy Dialysate with Monocytosis
  - During or after diarrheal illnesses (presumably viral gastroenteritis; unpublished observation)
  - Renal allograft rejection
    - Abdominal pain with cloudy fluid. Total WBC count: 3000 & 1400 with 47 & 49% monos.
    - Cx repeatedly negative
    - Symptoms resolved and total WBC fell to 45/mm³ immediately upon allograft nephrectomy

Yalavarthy and Teitelbaum. Perit Dial Int. 27: 466, 2007

Case “A”

- A 35 y/o woman with ESRD 2/2 to DM initiates CAPD, 4 x 2 L, using all 1.5% dialysate.
- After 2 months of uneventful PD the patient calls reporting the sudden onset of cloudy dialysate.
- She denies abdominal pain, fever, nausea, emesis, or diarrhea.
- Gram stain reveals no organisms.
- Cell count shows: WBCs 17/mm³, RBCs 683/mm³
- What is the most likely etiology? Others?

Causes of Hemoperitoneum

- Retrograde menstruation
- Ovulation
- Cyst rupture (ovarian, hepatic, renal)
- Peritoneal adhesion formation
- Hypertonic dialysate
- Strenuous exercise
- Catheter-associated trauma
- Malignancy (colon, renal)
Hemoperitoneum…it Doesn’t Take Much

Atypical Cells of Malignancy

• Metastatic involvement of the peritoneum (e.g. endometrial adenocarcinoma)

• Lymphoma
  - de novo
  - recurrent

Diagnosis of Lymphoma in PD Fluid

• 39 y/o ♀ with ESRD 2/2 DM
• Cloudy dialysate on first day of training
• No fever, abdominal pain or other symptoms
• Fluid had WBC 3575/ mm³
  - 61 segs
  - 17 lymphs
  - 16 monos
  - 6 mesothelial and other
• Gram stain and culture negative

Teitelbaum, I. Unpublished
Non-cellular Causes of Cloudy Peritoneal Dialysate

- Fibrin
  - Initiation of PD
  - During/after peritonitis
- Triglycerides (Chylous)
  - Most commonly due to impaired lymphatic drainage

Abdominal Lymphatics
Triglycerides- 1

- Neoplastic involvement of the peritoneum (e.g. lymphoma)
- Recurrent peritonitis with sclerosis
- Trauma to lymphatics
- Pancreatitis
- SVC syndrome

The Pancreas is Directly Anterior to the Cisterna Chyli

Abdominal Lymphatics
Triglycerides- 2

- Drugs (dihydropyridine calcium channel blockers)
  - Manidipine
  - Benidipine
  - Nisoldipine
  - Nifedipine
  - Lercanidipine

Chylous Peritoneal Dialysate

Culture- Negative Peritonitis

- Historically, accounts for 15-20% of all peritonitis episodes
- With proper culture techniques should be much less
- Organisms to consider include:
  - atypical bacteria (HACEK and others)
  - fungi
  - viruses
  - mycobacteria
An Uncommon Cause of Culture Negative Peritonitis

• There have been reports of culture negative peritonitis associated with the use of amino acid-based dialysate (not available in the US).

• Seemingly due to a single contaminated batch of product.

• Cellular characteristics not defined

Follow-Up Testing on Day 3 of Peritonitis

• Derivation Cohort
  ➢ 565 episodes of peritonitis of which there were 100 treatment failures (loss of catheter (n=70) or patient death (n=30))
  ➢ In multiple logistic regression analyses, peritoneal dialysate white count ≥ 1090/mm³ on day 3 was an independent prognostic marker for treatment failure after adjustment for conventional risk factors (hazard ratio 9.03; p < 0.0001).


Day 3 AUC = 0.80
Sensitivity 75%
Specificity 74%

Follow-Up Testing on Day 3 of Peritonitis

• Validation Cohort
  ➢ Different institution
  ➢ 207 episodes of peritonitis with 16 treatment failures

Summary and Conclusions

• PD fluid cell count should be interpreted in the context of dwell time and volume.
• PD patients presenting with abdominal pain with no clear cause should be presumed to have peritonitis until proven otherwise.
• Remember the “differential” and non-infectious causes of cloudy dialysate.
• I do not recommend routinely checking the fluid on day three of antibiotic therapy; I do so only if the patient is not responding to therapy.
Cloudy Dialysate and Negative Routine Cultures

- Cellular
- Atypical Cells
- Typical Cells
- Acellular
- Fibrin
- Triglycerides

Consider Culture for Atypical Infections

History
- Exam
- Medications

Treat Accordingly

Rocklin and Tettelbaum Sem Dial 14: 37, 2001
Interpreting the Cell Count

This is dependent on dwell time and amount of effluent in the abdomen.

- APD without a daytime exchange—infuse 1 liter and wait 1-2 hours, use differential
- APD presenting at night will have short dwells, use differential