Decreasing the Incidence of Peritonitis

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University of Pittsburgh
Outline of talk/learning objectives

- Approaches to prevent peritonitis
  - Preventing peritonitis thru training
  - Preventing enteric peritonitis
  - Preventing peritonitis via exit site infection
  - Preventing peritonitis from dental procedures and gynecologic causes

- Calculating peritonitis rates and monitoring outcomes
Influence of PD training nurses’ experience on peritonitis rates

- Retrospective observational single center
- Disconnect systems used; CAPD mostly
- One nurse trained two patients at one time
- Nurse orientation was 6 weeks
- Patient training averaged 5 hours per day, # days dependent on patient

RESULTS:
The nurses with the most experience trained the patients who had the shortest time to 1st Gram positive peritonitis!!

Exactly the opposite of what I would expect.

Program had recently implemented newer teaching and training techniques using **adult learning theory**. They felt the more established nurses did not embrace this approach as readily.

ISPD web site has a section on Training the Trainer

Principles of Adult Learning

• **Motivation**: preparation for the lesson

• **Reinforcement**: practice under observation

• **Retention**: retraining important

• **Transference**: ability to use information taught in new setting—example, response to contamination

http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/adults-2.htm
Multi-center Gambro Trial of PD education

Developed a curriculum ‘PD Directions’ based on adult learning theory
- Focus on what the learner needs to learn rather than on what the teacher needs to teach.
- Uses learning objectives

Time of training dependent in part on learner variables

<table>
<thead>
<tr>
<th></th>
<th>Adult learners method</th>
<th>Control method</th>
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</thead>
<tbody>
<tr>
<td>pre training</td>
<td>0.60</td>
<td>0.36</td>
</tr>
<tr>
<td>post training</td>
<td>0.34</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Methods used to teach PD

- Demonstration, while teaching theory
- Patient practiced using a doll or PD apron
- Thorough hand washing emphasized
- Test given at the end of training to ensure learning objectives met

Chen et al PDI 2008; 28 (suppl 3): S72-S75
### Independent predictors of peritonitis

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>HR</th>
<th>p value</th>
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</thead>
<tbody>
<tr>
<td>Late arrival for training</td>
<td>1.56</td>
<td>0.04</td>
</tr>
<tr>
<td>Baseline albumin</td>
<td>2.0</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Not significant: DM, age, Charlson comorbidity index

*I think the relationship between arriving late for training and subsequent peritonitis risk has to do with motivation*

Chow et al  NDT  2007; 22: 545-551
Chow paper gives an excellent description of what the PD curriculum needs to include:

- Patient able to perform procedure safely
- Recognizes peritonitis
- Able to trouble shoot with appropriate responses

Teaching the patient about contamination

- The patient must *recognize* contamination
- The patient needs to know how to *respond* to contamination
- The health care **team** needs to know how to respond to contamination
RCT of two connection systems for CAPD

System one with disc

System two with luer lock

Wong et al  AJKD 2006; 48: 464-472
Peritonitis rates by organisms

Episodes of peritonitis

- System with disc: ANDY-Disc
  - 122 dialysis years
  - 0.52 episodes/year

- System with luer lock: UltraBag
  - 125 dialysis years
  - 0.34 episodes/year
There was a relationship between product defect and peritonitis for the system with the disc connection.

Leakage of bags was the most common defect.
# Ratio of peritonitis incidence for the disc connection system versus the luer lock system by center

<table>
<thead>
<tr>
<th>Center</th>
<th>Ratio of peritonitis rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.09</td>
</tr>
<tr>
<td>2</td>
<td>4.41</td>
</tr>
<tr>
<td>3</td>
<td>2.25</td>
</tr>
<tr>
<td>4</td>
<td>0.63</td>
</tr>
<tr>
<td>5</td>
<td>1.26</td>
</tr>
<tr>
<td>6</td>
<td>1.94</td>
</tr>
</tbody>
</table>

**NOTE TREMENDOUS VARIATION FROM ONE UNIT TO ANOTHER**

Perhaps some center were better than others in teaching their patients to recognized and respond to contamination.
Protocol for contamination

- Patient recognizes contamination (leaking bag, dropping end of catheter in lap, cat gnawing on tubing, etc)

  Dropping the end of the catheter without the cap can cause many types of peritonitis

- Patient calls the unit

  Cats can cause Pasturella peritonitis
Unit takes appropriate approach (tubing change and/or prophylactic antibiotics)

**Algorithm for PD Contamination**

- **Clamp on transfer set remained closed**
  - Patient *not* to proceed with dialysis
  - Call dialysis center immediately
  - Sterile tubing change done by PD nurse

- **Clamp on transfer set open**
  - Close clamp
  - Patient *not* to proceed with dialysis
  - Call dialysis immediately
  - Sterile tubing change by PD nurse and prophylactic antibiotic
Retraining and home visits may be important to lower peritonitis risk

- Overall peritonitis rate: 1 episode/29 mo
- A lower peritonitis rate was associated with centers that had:
  - Pre-dialysis education
  - Home visits
  - Re-training

Observational study in 120 Italian PD centers
Another multi centered Italian study
  – 353 patients answered a questionnaire
  – 191 patients had home visits with a score card
23% were non-compliant with exchange procedure.
This was associated with higher peritonitis rates.

Russo et al  KI suppl 2006: 103: S 127-32
Assessment at 6 months of PD procedure in 130 Chinese pts

• Prospective observational single center study. Those with previous peritonitis excluded (bias).
• Training 3-5 days, 3-4 h/day but tailored to learner.
• Primary outcome: subsequent peritonitis
• Results:
  – 30% of all were suspected of contamination
  – Those not wearing a mask/cap were at higher risk for early peritonitis (45% peritonitis free at 1 year vs ~95% peritonitis free in those who did wear mask/cap)

Dong, Chen PDI 2010; 30: 440-447
Summary of PD training to prevent peritonitis

• The PD nurse **trainer must be trained**
• **Adult learning theory** as applied to PD is a sound educational approach
• Teaching problem solving to include **contamination** and response is critical
• **Re-training** may very well prevent peritonitis

Look at the ISPD guidelines:  Bernardini et al PDI 26: 625-632, 2006
GI sources of peritonitis

- Transmural migration
- Bowel ischemia
- Diverticulitis
- Colitis
- Cholecystitis
- Perforation of an organ
- GI procedures
Constipation, procedures and intra-abdominal pathology can be sources of peritonitis

Possible translocation of bacteria with constipation, enemas, procedures
Procedures can cause peritonitis

<table>
<thead>
<tr>
<th>Procedure</th>
<th>#episodes</th>
<th>organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental</td>
<td>5</td>
<td>streptococcus</td>
</tr>
<tr>
<td>Colonoscopy</td>
<td>9</td>
<td>E.coli, enterococcus, anaerobes</td>
</tr>
<tr>
<td>Barium enema/proctoscopy</td>
<td>2</td>
<td>Enterobacter, polymicrobial</td>
</tr>
<tr>
<td>Liver biopsy</td>
<td>1</td>
<td>Bacteroides</td>
</tr>
<tr>
<td>Lap cholecystectomy</td>
<td>1</td>
<td>Enterococcus</td>
</tr>
<tr>
<td>Perc endoscopic gastrostomy</td>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>Endometrial bx/hysteroscopy with polypectomy</td>
<td>2</td>
<td>Candida/streptococcus</td>
</tr>
</tbody>
</table>

From Fried…Piraino. PDI 2000;20: 343-345
Peritonitis after colonoscopy

Two cases of peritonitis after colonoscopy and polypectomy
Both pts grew E coli, 2nd also grew Klebsiella and Enterococcus

Poortvliet et al  J of Med 2010; 68: 377378
Patients with hypokalemia have a strikingly higher peritonitis rate than in those without hypokalemia.

Prevalence of peritonitis

\[
\begin{array}{c|c}
K < 3.5 \text{ mEq/L} & K 3.5 \text{ or higher} \\
6 & 2 \\
\end{array}
\]

Bacteria in the colon migrate across the visceral peritoneum and enter the peritoneal cavity which is filled with dialysis fluid which inhibits immune function. Peritonitis results.
What about diverticulosis?

<table>
<thead>
<tr>
<th></th>
<th>With</th>
<th>Without</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>25</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td>65</td>
<td>58</td>
<td>0.033</td>
</tr>
<tr>
<td>Enteric peritonitis</td>
<td>0.47</td>
<td>0.22</td>
<td>0.001</td>
</tr>
</tbody>
</table>

in episodes per year at risk

Organisms were: E coli, Klebsiella, Enterococcus, Enterobacter, Bacteroides, other

Yip .... Lo WK  PDI 2010; 30: 187-191
Non-Pseudomonas Gram-negative peritonitis in Australia

- 23% of all peritonitis episodes (256 pts), a rate of 0.14/year
- E coli, klebsiella, Enterobacter, Serratia, Acinetobacter, Proteus, Citrobacter and multiple organisms
- Risk factors: older age
- Antibiotic cure rate 59%
- Higher risk of hospitalization, catheter removal, perm transfer to HD, death

Jarvis…Johnson KI 2010; 78: 408-414
Summary of preventing GI sources of peritonitis

- Avoid constipation.
- Treat hypokalemia.
- Prophylaxis for GI procedures.
- Diverticulosis-- ?
- Colitis– unclear how to prevent peritonitis.
PD catheter can develop a biofilm containing live organisms which can lead to refractory, relapsing or recurrent peritonitis.
The PD catheter is often the entry point of infection.
Double cuff catheter seems to outperform the single cuff catheter

The double cuff catheter reduces the risk of S. aureus peritonitis ($p<0.001$) and a trend toward over all lower rate ($p=0.08$)
Canadian study  N=4247 incident PD pts, peritonitis rates 0.36 episodes per year
Nessim, Bargman, Jassal  NDT 2010 25: 2310-2314
No particular catheter recommended

However, ISPD clinical practice guidelines do not recommend any particular type of catheter but emphasize importance of a dedicated team.

PDI 2010; 30: 424-429
S. aureus CAPD related infections are associated with nasal carriage

*S. aureus* episodes/year

<table>
<thead>
<tr>
<th>Condition</th>
<th>Nasal Carrier</th>
<th>Non Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit site infection</td>
<td>0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>0.30</td>
<td>0.15</td>
</tr>
<tr>
<td>Catheter loss</td>
<td>0.10</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Data from Lye et al, 1994  Nasal carriage defined as min of 2 of 3 NC positive
Exit site antibiotic prophylaxis as part of routine care can markedly decrease risk of ESI and peritonitis secondary to this.

Randomized Trial Comparing Mupirocin to Gentamicin Cream at the Exit site in PD Patients

From the University of Pittsburgh University of Rochester and West Virginia University

Bernardini ... Piraino JASN 2005; 16: 539-545.
Double blinded multi-center RCT of exit site gentamicin vs mupirocin

Exit site infections in episodes per year at risk

Bernardini….Piraino  JASN 2005: 16: 539-545
Treatment of exit site and tunnel infections

- Oral antibiotic as effective as IV or IP, unless MRSA.
- I treat for 2 weeks, and see them every 2 weeks to decide on continuing antibiotics.
- Continue antibiotics until exit site appears normal.
Indications for catheter removal for exit site and tunnel infections

- If a catheter infection is present with peritonitis
- Less clear is timing for chronic exit-site and tunnel infections
  - Involvement of inner cuff
  - Refractory exit-site/tunnel infections; 6-8 wk of antibiotic therapy
  - Sepsis caused by catheter infection (rare)

1997 Gokal et al. ISPD Guidelines
The goal in managing exit site and tunnel infections is to prevent peritonitis---not save the PD catheter.
Teeth, periodontal disease and dental procedures

Transient bacteremia from dental work can lead to peritonitis

Not much known about this. I had a lady with mm on PD– she developed Streptococcus salivarius peritonitis shortly after extensive dental procedure
Gynecologic sources of peritonitis

- Peritoneal vaginal fistula
- Peritonitis associated with vaginal leakage
- Post-hysteroscopy fungal peritonitis
- E. coli peritonitis after vaginal delivery
- Vaginal colonization w Gp B Streptococcus and peritonitis

Neumann Nephrol Nurs J 2010 37(2): 177-178
Coward et al Brit Med J 21982; 284: 1529
Li AJKD 1993; 21: 446-8
Tison PDI 1996; 16: suppl 1 S 489-91
Scanziani R NDT 1999; 14: 2222-2224
Monitoring peritonitis in PD program

- Peritonitis *rates*
- and organism *rates* (which gives indication of cause)
- Examination of potential causes
Peritonitis rate:

# peritonitis episodes ÷ time at risk in group

Example: 7 episodes in 6 patients in a program with 70 patients over the year with 44 years at risk (528 months)

RATE:
528 months ÷ 7 episodes = One episode per 75 mo

Or
7 episodes ÷ 44 years = 0.16 episodes per year

PD Registry Data--DCI Oakland
Look at the % of patients in the program with peritonitis for each year.

Data from DCI of Oakland PD Registry
The organism gives important clues to causality:

<table>
<thead>
<tr>
<th></th>
<th>#</th>
<th>RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S aureus</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>CNS</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>Other GNR</td>
<td>5</td>
<td>0.11</td>
</tr>
<tr>
<td>Fungus</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sterile/no culture</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>Polymicrobial</td>
<td>3</td>
<td>0.07</td>
</tr>
</tbody>
</table>

# Note similarity to Australian registry where this was 0.14/y. Total rate 0.26 episodes per year (Australian registry 0.61)

Data from 2008, 44 dialysis years at risk Univ of Pittsburgh PD Registry
Peritonitis is often examined as % of episodes for different organisms.

Data from Univ of Pittsburgh Registry 2004-2008: Total rate is 0.28 episodes per year, 214 dialysis years at risk. Adapted from Piraino PDI 2010; 30: p 278.
Examine peritonitis by organism

Data from Univ of Pittsburgh Registry 2004-2008: Total rate is 0.28 episodes per year 214 dialysis years at risk Adapted from Piraino PDI 2010; 30: p 278
Example: Comparison of a single center to large national data base

- In Australia 2003-2006\(^1\):
  - Peritonitis rate \(0.61/\text{year}\)
  - CNS rate \(0.16/\text{year}\) \((26\% \text{ of all})\)

- University of Pittsburgh program, 2009:
  - Peritonitis rate \(0.30/\text{year}\)
  - CNS rate \(0.08/\text{year}\) \((26.6\% \text{ of all})\)

\(^1\) Fahim et al  NDT 2010; 25: 3386-3392
Quality improvement is an iterative process

By examining the peritonitis data by organisms, one can often come up with etiology (contamination, exit site infection, bowel source, etc), and a multi-disciplinary team develops a plan to address the problem.

This approach must be driven by the data.
Summary: Preventing peritonitis

- Training is all important!!
- From GI sources– prevent hypokalemia and constipation
- From PD catheter– ES antibiotic prophylaxis
- Follow peritonitis rates closely

The end
Question 1

Your patient calls. She dropped the cap for the PD catheter on her lap, picked it up, and placed it on the end of the catheter. She then realizes this might have been a mistake and she immediately calls your PD nurse. What is the correct approach:

1) Your nurse tells her not to worry about it, she will be just fine as the clamp was closed.
2) Your nurse tells her to come in to have the extension tubing changed.
3) Your nurse tells her to come in to have the extension tubing changed and to get prophylactic antibiotics
4) Your nurse tells her she was stupid and shouldn’t be on PD.
Answer

- Number 2 (extension tubing changed)

- There is no need for antibiotics as the patient did not infuse after the contamination.
Your patient is to have a colonoscopy as part of his transplant work up. Your instructions are:

1) Not to worry, all will be fine.

2) To drain his abdomen before the procedure and re-start the night after the procedure.

3) To be sure that the GI team provides prophylactic antibiotics to cover enteric organisms.

4) Answer is combination of 2 and 3
• The answer is 4

• The abdomen should be drained because this theoretically decreases the risk of peritonitis from trans-mural migration.

• The patient should receive propylactic antibiotics before the procedure since colonoscopy has been reported to lead to peritonitis.
You notice that your patients seem to be having a lot of peritonitis. Your approach:

1. Calculate the peritonitis rate and compare to the prior year.
2. Meet as a team with the nurse to review all episodes of peritonitis and do a root cause analysis.
3. Have the nurses re-assess technique in all patients as part of the next clinic visit.
4. All of the above.
• 4, all of the above

• It often takes a multi-pronged attack to lower peritonitis rates.