Preventing Peritonitis:
Why do some do it better? Reducing Risks in PD
<table>
<thead>
<tr>
<th>country</th>
<th>reference</th>
<th>year</th>
<th># centers or #pts</th>
<th>episodes /yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taiwan</td>
<td>Tzen-Wen</td>
<td>2008</td>
<td>100 adults</td>
<td>0.06</td>
</tr>
<tr>
<td>Japan</td>
<td>Hoshii</td>
<td>2006</td>
<td>130 children</td>
<td>0.17</td>
</tr>
<tr>
<td>China</td>
<td>Fang</td>
<td>2008</td>
<td>496 adults</td>
<td>0.20</td>
</tr>
<tr>
<td>Japan</td>
<td>Nakamoto</td>
<td>2009</td>
<td>139 adults</td>
<td>0.22</td>
</tr>
<tr>
<td>US</td>
<td>Qamar</td>
<td>2009</td>
<td>137 adults*</td>
<td>0.24</td>
</tr>
<tr>
<td>Austria</td>
<td>Kipriva-Altfart</td>
<td>2009</td>
<td>332 adults</td>
<td>0.24</td>
</tr>
<tr>
<td>Qatar</td>
<td>Shigidi</td>
<td>2010</td>
<td>241 adults</td>
<td>0.24</td>
</tr>
<tr>
<td>Canada</td>
<td>Fang</td>
<td>2008</td>
<td>312 adults</td>
<td>0.33</td>
</tr>
<tr>
<td>Canada</td>
<td>Nessim</td>
<td>2009</td>
<td>4247 adults*</td>
<td>0.36</td>
</tr>
<tr>
<td>France</td>
<td>Castrale</td>
<td>2010</td>
<td>1631 elderly</td>
<td>0.36</td>
</tr>
<tr>
<td>US</td>
<td>Mujais</td>
<td>2006</td>
<td>35 centers*</td>
<td>0.37</td>
</tr>
<tr>
<td>Spain</td>
<td>Perez Fontan</td>
<td>2009</td>
<td>641 adults</td>
<td>0.38</td>
</tr>
<tr>
<td>Portugal</td>
<td>Rodrigues</td>
<td>2006</td>
<td>312 adults</td>
<td>0.39</td>
</tr>
<tr>
<td>Canada</td>
<td>Mujais</td>
<td>2006</td>
<td>26 centers</td>
<td>0.43</td>
</tr>
<tr>
<td>Australia</td>
<td>Jarvis</td>
<td>2010</td>
<td>4675 adults*</td>
<td>0.60</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Ruger</td>
<td>2009</td>
<td>205 adults*</td>
<td>0.60</td>
</tr>
<tr>
<td>Scotland</td>
<td>Kavanaugh</td>
<td>2004</td>
<td>1205 adults*</td>
<td>0.62</td>
</tr>
<tr>
<td>Aus/NZ</td>
<td>Fahim</td>
<td>2010</td>
<td>4675 adults*</td>
<td>0.62</td>
</tr>
<tr>
<td>Brazil</td>
<td>Mores</td>
<td>2009</td>
<td>680 adults*</td>
<td>0.74</td>
</tr>
<tr>
<td>Turkey</td>
<td>Akman</td>
<td>2009</td>
<td>132 children</td>
<td>0.77</td>
</tr>
<tr>
<td>UK</td>
<td>Davenport</td>
<td>2009</td>
<td>1904 pt yrs*</td>
<td>0.82 CAPD, 0.66 APD</td>
</tr>
<tr>
<td>Israel</td>
<td>Cleper</td>
<td>2010</td>
<td>29 children</td>
<td>1.66</td>
</tr>
</tbody>
</table>

* Registry data
The differences…

- An individual patient, on average, may expect to have peritonitis as rarely as
  - once every **17 years** in one center,
  - or as frequently as once every **7 months** in another.

- Even at centers within a single country, there is often a marked variation in the peritonitis rate.
  - Scottish registry has centers with rates that range from 0.43 episodes (**28mo**) to 0.89 episodes per year (**13mo**)  
  - London Thames centers vary from 0.14 episodes (**>7yrs**) to 1.0 episodes per year (**12 mo**)  
  - Austrian Study Group centers range from 0.07 episodes (**>14yrs**) to 0.60 episodes per year (**20mo**)
Technique survival

- highly affected by infection rates
  - Infection is leading cause of transfer off PD
Possible reasons for differences in infection rates...

- differences in patient training
- differences in infection-prevention protocols
- variations in the accuracy with which peritonitis data is collected and reported
GOOD OUTCOMES

- Achieved when a dedicated group of professionals continuously work to improve the care for PD patients.
Key Issue:

Goal: to reduce the risk of poor outcomes for PD patients.

What outcomes do you want to improve?
If you cannot measure it, you cannot manage it or improve it.
Reducing Risk of Infections


- Proper catheter insertion and post-op care
- Chronic exit site care
- S.aureus prophylaxis
- Hand washing per CDC / WHO protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement
Prevention Begins with Catheter Insertion


- **Access team**
  - Coordinate exit site location and timing of referral for surgery
  - Includes availability of catheter manipulation and urgent removal
  - Bowel prep pre-op, flushing post insertion

- **Local expertise guide insertion techniques**
  - No catheter shown to be superior

- **Antibiotics pre-op : single dose peri-operatively**

- **Sterile post op care**

- **Immobilize catheter to promote healing and reduce trauma**

- **Annual audit of catheter insertions**
  - >80% functioning at 1 year
  - Bowel perforation <1%, significant hemorrhage <1%,
  - ESI or peritonitis within 2 weeks <5%.
Goals of Post-op care:

- Prevent colonization during healing
- Reduce trauma at exit and cuff(s)

- restrict dressing changes to PD staff
  - aseptic technique
- cleanse with non-irritating agent
- non-occlusive dressing
- immobilize catheter
Chronic Exit Site Care


- Begins after complete healing
  - immobilize catheter
  - hand washing prior to exit site care
  - daily exit site care
    - liquid antibacterial soap or disinfectant
    - examine visually, then cleanse gently
    - dry thoroughly
    - S.aureus prophylaxis
Well Healed Exit Sites

- Skin tight around exit
- No gaping
- Area dry with normal skin color
Choices for cleansing exit site:

- Povidone-iodine
- Hydrogen peroxide
- Sodium hypochlorite
- Chlorhexidine
- Acetic acid
- Alcohol
- Non-ionic surfactant
  - Pure soap
  - Antibacterial soap

**Cytotoxic?**

- yes (if >0.001% conc)
- yes (if >0.003% conc)
- yes (if >0.24% conc)
- yes (if >0.005% conc)
- yes (if >0.24% conc)
- yes (to open wound)
  (not antiseptic)

- Lineaweaver et al, Topical antimicrobial toxicity. Arch Gen Surgery 120(3), 1985
- Doughty D. A rational approach to the use of topical antiseptics. J Wound Ost Cont Nurs 21(6), 1994
- Tatnall et al, Comparative study of antiseptic toxicity on basal keratinocytes, transformed human keratinocytes and fibroblasts. Skin Pharm 3(3), 1990
- Harsbargen et al. Exit-site care;is it time for a change? Perit Dial Int, 13 (suppl 2), 1993
Reducing Risk of Infections


- Proper catheter insertion and post-op care
- Chronic exit site care
- S.aureus prophylaxis
- Hand washing per CDC protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement
**S. Aureus prophylaxis:**
ISPD Recommendations 2010

**Choose one:**

- **Exit site mupirocin or gentamicin**
  - daily after cleansing
  - in all patients

- **Intranasal mupirocin**
  - Monthly, BID x 5 days
  - Reduces SA exit site infections, not SA peritonitis

**Target rates of infection:**
S. Aureus catheter infections <0.05/year
  - 1 episode every 240 months or 20 years

S. Aureus peritonitis <0.06/year
  - 1 episode every 200 months or 16.7 years

**S aureus ESI** are reduced with mupirocin prophylaxis

![Bar chart showing the reduction of S aureus ESI/year with mupirocin prophylaxis compared to control. The chart includes data from different studies: Perez-Fontaine, Mupirocin Study Group, Bernardini, Thodis, and Casey. The chart notes that the study is not randomized.](image)
Effect of *S aureus* prophylaxis on prevention of *S. aureus* peritonitis

S aureus peritonitis/year

- The Mupirocin Study Group
- Bernardini
- Thodis
- Mup
- Gent

WCPD Vancouver 2014
Meta-Analysis of Mupirocin Prophylaxis to prevent S.aureus infections in PD patients

- 10 studies (3 RCT’s and 7 historical cohort studies)
  - 63% reduction in all S. aureus infection risk with the prophylaxis
    - 66% reduction in S. aureus peritonitis
    - 62% reduction in S.aureus exit site infection

- 2009 meta –analysis and RCT’s
  - 72% reduction in S.aureus exit site infections by
  - 40% reduction in S.aureus peritonitis

Exit site mupirocin has been found to be more effective than intranasal mupirocin in reducing S.aureus peritonitis
## Mupirocin versus Gentamicin at the Exit Site

- **prospective, double-blind, multi-centered, randomized trial:**

<table>
<thead>
<tr>
<th></th>
<th>mup</th>
<th>gent</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter infections</td>
<td>0.54</td>
<td>0.23</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td>S. aureus</td>
<td>0.06</td>
<td>0.08</td>
<td>0.44</td>
</tr>
<tr>
<td>Pseudomononas</td>
<td>0.11</td>
<td>0</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>0.52</td>
<td>0.34</td>
<td>0.03</td>
</tr>
<tr>
<td>S. aureus</td>
<td>0</td>
<td>0.03</td>
<td>0.14</td>
</tr>
<tr>
<td>Pseudomononas</td>
<td>0.04</td>
<td>0</td>
<td>0.14</td>
</tr>
</tbody>
</table>
Prospective trial, assigned 1:1 to either daily exit site gentamicin or daily exit site mupirocin

81 patients at single center followed for 1 year; not controlled for *S. aureus* nasal carriage; no power calculations.

Mupirocin group significantly older with more comorbidities
<table>
<thead>
<tr>
<th></th>
<th>gentamicin</th>
<th>mupirocin</th>
<th>p</th>
<th>ns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESI/yr</strong></td>
<td>0.38</td>
<td>0.20</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td><em>S. Aureus</em></td>
<td>0.13</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>meth sens</td>
<td>0.05</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>MRSA</em></td>
<td>0.08</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. Aeruginosa</em></td>
<td>0.18</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Peritonitis/yr</strong></td>
<td>0.33</td>
<td>0.27</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td><em>S. aureus</em></td>
<td>0.03</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. Aeruginosa</em></td>
<td>0.05</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>total <em>Gm neg</em></td>
<td>0.20</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion:** gentamicin equivalent to mupirocin applied daily to exit site but underpowered with short follow-up

- Retrospective review 2003-2007; no method for assignment to mup or gent
- 100 patients on either mup or gent at least 6 months; follow-up about 1 yr
- Excluded infections 1st 3 months after PD catheter inserted

<table>
<thead>
<tr>
<th></th>
<th>gent</th>
<th>mup</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, n</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Catheter inf</td>
<td>0.03</td>
<td>0.08</td>
<td>(episodes/year)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>S.aureus</td>
<td>0.03</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>g neg</td>
<td>0</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>pseudo</td>
<td>0</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Peritonitis</td>
<td>0.61</td>
<td>0.32</td>
<td>0.07</td>
</tr>
<tr>
<td>S.aureus</td>
<td>0.10</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>G neg</td>
<td>0.10</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>pseudo</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>0.20</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>strept</td>
<td>0.10</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Study concluded gentamicin not superior to mupirocin at exit site.
The Effect on Pathogens for Changing Antibiotic Prophylaxis

Pierce DA et al.  PDI 32(5):525-530: 2012
Retrospective observational study of two periods of prophylaxis
Decreased susceptibility Enterobacter and Pseudomonas with gent
Limitation: high rate no growth cultures both groups (30% & 19%)
Randomized study of 370 patients
- Comparing S. aureus prophylaxis
  - intranasal mupirocin 1/month
  - Medihoney antibacterial gel at exit site daily

**Results:**

*rates of exit site infection and peritonitis not different.*

But… Medihoney group had increased risk of infection for peritonitis in patients with DM.

Also… Medihoney group had high dropout rate due to skin irritation.
Effectiveness of different types of care of the peritoneal dialysis catheter: a systematic review.
Ques Aam et al. JB Database Systemic Review and Implementation Reprots. 11(9), 133-179, 2013

- reviewed all randomized studies 1996-2009
  - 9 randomized trials

- conclusions:
  - gentamicin cream at exit site better than mupirocin to decrease ESI and peritonitis
  - chlorhexidine better than povidone iodine to decrease ESI and P at 5-6 months
  - strict sterile technique imperative post op
Exit Site Infection of peritoneal catheter is reduced by the use of polyhexidine.


- Prospective randomized trial of daily exit site care for 12 months, single center
- S.aureus carriers Rx with intranasal mup BID x 7d

<table>
<thead>
<tr>
<th></th>
<th>NS+Povidone</th>
<th>NS+polyhexidine</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>ESI/yr</td>
<td>0.33</td>
<td>0.12 *</td>
</tr>
<tr>
<td>SA</td>
<td>0.11</td>
<td>0</td>
</tr>
<tr>
<td>Pseudo</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>P/yr</td>
<td>0.51</td>
<td>0.37</td>
</tr>
</tbody>
</table>

* all 3 ESI Pseudomonas aeruginosa

WCPD Vancouver 2014
Reducing Risk by Preventing Infections

- Proper catheter insertion and post-op care
- Chronic exit site care
- S.aureus prophylaxis
- Hand washing per CDC protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement
Indications for Hand Hygiene

- When hands are visibly dirty, contaminated, or soiled, wash with non-antimicrobial or antimicrobial soap and water.

- If hands are not visibly soiled, use an alcohol-based handrub for routinely decontaminating hands.

Guideline for Hand Hygiene in Health-care Settings.
*MMWR* 2002; vol. 51, no. RR-16. WHO 2009
Recommended Hand Hygiene

**Handrubs**
- Apply 3mL of 60-80% alcohol gel to palm of one hand, rub hands together covering all surfaces until dry
- Volume: should take 20-30 seconds to dry

**Handwashing**
- Wet hands with warm water (not hot), apply 3mL soap, rub hands together for at least 20 seconds
- Rinse and dry with disposable towel
- Use towel to turn off faucet
- Entire procedure takes 40-60 seconds
- If use bar soap, must use rack to drain and dry between uses

[www.CDC.gov/Handhygiene](http://www.CDC.gov/Handhygiene)  [whqlibdoc.who.int/publications](http://whqlibdoc.who.int/publications)  

CDC.Gov and WHO 2009

PD Patients must be taught aseptic technique, with emphasis on proper hand washing techniques.
Efficacy of Hand Hygiene Preparations in Killing Bacteria

- Good
- Better
- Best

- Plain Soap
- Antimicrobial soap
- Alcohol-based handrub*

* C. Difficile is NOT killed by alcohol---soap required

www.CDC.gov/Handhygiene
Can a Fashion Statement Harm the Patient?

Avoid wearing artificial nails, keep natural nails <1/4 inch if caring for high risk patients (ICU, OR)

Edel et. al, *Nursing Research* 1998:47;54-59
WHO 2009

WCPD Vancouver 2014
Relationship of hand dampness after hand washing to bacterial translocation following touch contamination

From Miller TE, Findon G. Perit Dial Int.17;1997:560-567

% decrease in bacterial numbers with wet and progressively drier hands

Thoroughly washed but inadequately dried

Time air drier used on hands, in seconds
Simple soap and water + alcohol gel versus alcohol gel alone.

22 PD patients

- Cultured prior to hand hygiene procedure and after
- Colony forming units significantly lower after use of alcohol alone
- Concluded that 70% alcohol gel alone is more effective in cleaning hands
Reducing Risk
by Preventing Infections

- Proper catheter insertion and post-op care
- Chronic exit site care
- S.aureus prophylaxis
- Hand washing per CDC protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement

Bender, Bernardini, Piraino. KI suppl, 2006;S44-54
Contamination Protocols

- If unclear whether clamp open or closed, assume it was open.

- Culture effluent post-contamination
  - If positive (even if effluent clear), full course of antibiotic Rx
    - Goal is to prevent inflammatory response of peritoneum to contaminant
  - Apply new sterile transfer set to re-establish sterile pathway
    - No alternative appropriate post contamination

- Pets in room of exchange may also cause contamination—especially with cycler

- Accidental disconnections and hole in systems will also cause contamination
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
Additional predictors of increased peritonitis risk:

**Malnutrition**
- Initial albumin <2.9 g/dL predicts >2 times higher rate of peritonitis

**Hypokalemia**
- Transmural migration of enterobacter

**Depression**

**Vitamin D**
Reducing Risks by Preventing Infections

- Proper catheter insertion and post-op care
- Chronic exit site care
- Hand washing per CDC protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement
Reduce risk of peritonitis due to relapse

- Defined as 2nd episode with same organism within 2-4 weeks of stopping antibiotics
- May be due to occult catheter infection
- Catheter replacement prevents further episodes
Reducing risks by Preventing Infections

- Proper catheter insertion and post-op care
- Chronic exit site care
- Hand washing per CDC protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement
Nystatin Prophylaxis to prevent Candida Peritonitis

- 10 year study (non-randomized) using historical controls
- Nystatin 500,000 u QID while on antibiotics

<table>
<thead>
<tr>
<th></th>
<th>Nystatin 1995-1999</th>
<th>Control 1999-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, n</td>
<td>320</td>
<td>481</td>
</tr>
<tr>
<td>Overall peritonitis</td>
<td>0.56/yr</td>
<td>0.44/yr</td>
</tr>
<tr>
<td>Candidia peritonitis</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>0.019/yr</td>
<td>0.011/yr</td>
</tr>
<tr>
<td>Antibiotic-related</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Candidia peritonitis</td>
<td>10/14</td>
<td>4/13</td>
</tr>
<tr>
<td></td>
<td>0.014/yr</td>
<td>0.003/yr</td>
</tr>
</tbody>
</table>

Peritonitis due to procedures

**ISPD 2010 Guidelines**

- **Transplant**
  - empty abdomen of fluid
  - antibiotic prophylaxis pre

- **Colonoscopy with polypectomy**
  - single IV dose ampicillin 2 gm + single dose aminoglycoside with or without metronidazole just prior to procedure
  - empty abdomen of fluid

- **Dental procedures**
  - single oral dose amoxicillin 2 gm two hours pre

- **Uterine biopsy**
  - empty abdomen of fluid
  - prophylaxis with antibiotic
Reducing risks by Preventing Infections

- Proper catheter insertion and post-op care
- Chronic exit site care
- Hand washing per CDC protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement
Home Visits

Remember—sometimes we do not see the problem until we see them at home!
• No pets in the room

• Periodically re-evaluate patient

• Home situation

• Ability to perform connections safely

• Appropriateness of equipment & technology

• Well water---use bottled water to clean exit site

• No connections in front of vents or fans
Reducing risks by Preventing Infections

- Proper catheter insertion and post-op care
- Chronic exit site care
- Hand washing per CDC protocols
- Careful training/retraining of the patient
- Contamination protocols
- Reducing the risk of peritonitis relapse
- Fungal and procedure-related prophylaxis
- Assessment of patient in their home
- Continuous Quality Improvement
Dialysate cultures

- **Important to identify the organism**
  - for appropriate antibiotic treatment
  - for identification of resistant organisms
  - to establish probable cause of infection
  - Ideally <10% culture negative (but always <20%)

- **Blood culture bottles are best**
  - 10 ml injected into aerobic and anaerobic bottles (ISPD)
    - Prep injection site for effluent sample with betadine drop for 5 minutes
      - Innoculated bottles incubated at 37°C
  - 50mL centrifuged has lowest culture-negative rate
    - <5% culture negative
    - …but not always practical
Summary of Prevention Tactics

- Reduce risks for developing catheter infection and peritonitis.
  - Reduce risks associated with PD catheter
  - Attention to handwashing
  - Careful training and retraining of patients
  - S.aureus prophylaxis
  - Fungal prophylaxis and procedure prophylaxis
  - Contamination protocols
  - Reduce risk of peritonitis relapse
  - Continuous Quality Improvement
    - Determine root cause of each peritonitis
  - Re-evaluate patient at home

Thank you.