Type of peritoneal dialysis catheter

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GUIDELINES

a. No peritoneal dialysis catheter has proven to be superior to the two-cuff standard Tenckhoff catheter in the prevention of peritonitis. (Level II evidence)
b. Coiled-tipped catheters are associated with increased risk of technique failure compared with straight catheters. (Level II evidence)

SUGGESTIONS FOR CLINICAL CARE
(Suggestions are based on level III and IV evidence)

No recommendation.

IMPLEMENTATION AND AUDIT

All renal units should maintain data on all PD-related problems including exit site infections (ESIs), tunnel infections, peritonitis, catheter malfunction rates and catheter survival times. This data should be submitted to the Australia and New Zealand Dialysis and Transplant (ANZDATA) registry.

BACKGROUND

Successful peritoneal dialysis (PD) is reliant upon access to the peritoneal cavity via a catheter. The catheter should limit the chance of infection gaining entry to the peritoneal cavity, as well as maximise the flow of PD fluid in and out to facilitate dialysis. Infections and mechanical complications are two of the leading causes of PD technique failure.

There are a number of variations on the standard single- or double-cuff Tenckhoff catheter that are now available which have been developed in an attempt to improve both the infectious complications, such as peritonitis and ESIs, and mechanical complications, such as flow problems and tip malposition. These variants include a coiled-tip Tenckhoff, Toronto Western Hospital catheter with silicone discs perpendicular to the catheter along the intraperitoneal segment, the Lifecath™ catheter with a disc positioned on the parietal peritoneal surface, the T-fluted (Ash Advantage) catheter with a T-shaped intraperitoneal segment, the swan neck, with an inverted U shaped arc, the Moncrief-Popovich which is similar to the swan neck but has a longer external skin cuff of 2.5 cm, the pail handle catheter (Cruz), which has 2 right angle bends and small cuffs for peritoneoscopic insertion, the swan neck preternal catheter (Missouri), the Twardowski, which is composed of 2 silicone rubber tubes that are connected with a titanium connector at implantation with a coil and a longer subcutaneous tunnel, and the de Paolo self-locating catheter which is similar to a classic Tenckhoff with a 12 g tungsten weight at the internal tip, and is used widely in Italy and elsewhere.

The aim of this guideline was to establish whether there is any PD catheter that has an advantage in reducing the incidence of peritonitis. Recently, some data has emerged with regards to catheter
type and other complications such as mechanical problems, and so this has been included in the guideline.

SEARCH STRATEGY

Databases searched: MeSH terms and text words for peritoneal dialysis were combined with MeSH terms and text words for catheter and peritonitis and then combined with the Cochrane highly sensitive search strategy for randomised controlled trials. The search was carried out in Medline (1950 – November Week 3, 2009). The Cochrane Renal Group Trials Register was also searched for trials not indexed in Medline.

Date of searches: 9 December 2009; update search 15 October 2010.

WHAT IS THE EVIDENCE?

Systematic reviews

Strippoli and colleagues [1] performed a Cochrane systematic review of catheter-related interventions to prevent peritonitis. This review examined different surgical techniques, the use of different types of PD catheters, and the use of different bag systems (for example the Y-set) as possible factors influencing rates of peritonitis and other infectious complications including ESI s and tunnel infections. In total, there were 37 trials of 2882 patients identified but trial quality was found to be variable, with almost no studies meeting all of the CONSORT criteria for adequacy of reporting.

With regards to trials of different types of PD catheter, the review identified 8 trials of 405 patients which examined this end-point comparing straight versus coiled catheters and found no difference in peritonitis, peritonitis rate, ESIs or tunnel infections.

Prospective randomised controlled trials

There have been two recent reasonably-sized, randomised trials of different catheter types with end-points of peritonitis. The first, by Johnson et al was a trial of 132 patients randomised to either straight or coiled swan-neck Tenckhoff catheters with the primary outcome of time to catheter malposition. [2] For this outcome, there was no difference in the time to laparoscopic reposition between the two cohorts (log-rank score 0.41; P=0.52) but there was a significantly worse median technique survival for coiled catheters (1.5 [95% CI 1.2-1.8] versus 2.1 [95% CI 1.8-2.5] years, P <0.05). Secondary analyses revealed no differences in infection rates (peritonitis or exit-site) or patient survival between the two techniques.

A second recent study by Lo and colleagues randomised 93 patients to conventional straight catheters, straight swan-neck catheters or swan-neck coiled catheters. [3] The hypothesis of the study was that the addition of a coiled-tip to a swan-neck catheter might offset the disadvantage of higher tip migration rates seen in other studies of swan-neck catheters, which seem to be associated with lower infectious complications. This is thought to be due to a downward-facing exit site. The major findings of the study were of no significant difference in infections (ESIs or peritonitis) in swan-neck compared with straight catheters, and a high rate of catheter tip migration in swan-neck coiled catheters (31.2%) compared with conventional straight catheters (12.5%, P=0.022).

Eklund et al randomised 60 patients to Tenckhoff catheters with either single or double Dacron cuffs and showed there was no significant difference in the probability of developing the first episode of peritonitis. [4] There was also no significant difference in the probability of developing ESI or catheter survival at 1 or 2 years (95.5% vs 96.7% at 1 year and 82.7% vs 79.9% at 2 years).
Akyol et al conducted a prospective, randomised, double-blind comparison of 39 patients and showed no difference in peritonitis rates between patients with double-cuff curled Tenckhoff (15 in 255 patient-months) and double-cuff conventional straight catheter (19 in 266 patient-months). [5] There was also no difference in ESIs, mechanical complications or catheter survival at 78 weeks.

Several other small RCTs found no significant differences between several other variations of catheter types with single- or double-cuffs, swan-neck or straight, and these trials were included in the systematic review mentioned above. None of them, on their own, had an effect on the conclusion of the review.

**Retrospective studies**

The United States Renal Data System 1992 Annual Report retrospectively documented less peritonitis with the double-cuff than the single-cuff catheter. Warady et al reported on data in the North American paediatric dialysis database which has 1383 courses of peritoneal dialysis documented in it. [6] The incidence of peritonitis was found to be lower with the double-cuff than the single-cuff catheter (1/15.1 vs 1/12.6 months, P < 0.01).

Honda et al from the Japanese Registry in Pediatric CAPD patients documented better catheter survival with the double-cuff vs single-cuff catheter (82.2% vs 69.0% at 1 year and 54.2% vs 43.2% at 2 years) but did not comment on the difference in peritonitis between the two groups in a retrospective review of 434 paediatric PD patients. [7]

Hwang and Huang compared 26 patients with the swan neck Missouri 2 catheter from 1992-1994 with 166 patients with straight Tenckhoff catheters from 1986-1992. [8] Peritonitis was not reported on but they did find that there was no difference in ESIs (SN 55.7% vs T 55.8%), tunnel infections (SN 7.7% vs T 9.1%) or catheter tip migration (SN 7.7% vs T 5.2%). There were, however, fewer cuff extrusions and pericatheter leakages and a better catheter survival at 1, 2 and 3 years with the swan neck Missouri 2 catheter (SN 90.0%, 80.2%, 67.9% vs T 84.7%, 67.9%, 54.0%).

Gadallah et al retrospectively analysed 462 patients over a 6-year period and compared the double-cuff, straight catheter with a curled-end (n=219), with the double-cuff, 60 degrees swan neck catheter with a coiled end (n=243). Although they did not assess peritonitis or catheter survival, they did find significantly less catheter tip migration in the swan neck group (< 1% vs 15%, P = 0.002). [9]

A retrospective study over 3 years compared 23 patients with a swan neck Tenckhoff catheter and 49 controls with a straight Tenckhoff catheter from the commencement of dialysis. There were significantly more episodes of peritonitis in the swan neck group (24 in 12 compared with 9 in 8 patients [1.1 vs 0.3 episodes of peritonitis/patient-year]) but no difference in ESIs, tunnel infections or cumulative catheter survival at 3 years (SN 23.6% vs T 25.0%). [10]

Twardowski et al reported on a 6-year experience with swan neck catheters and compared the swan neck prototype (n=27), swan neck Missouri 2 with a straight IP segment (n=105) and a coiled IP segment (n=49). They found no significant difference in peritonitis or 3-year catheter survival rates. [11]

Ash et al inserted 18 Ash Advantage (T-fluted) catheters in 10 new dialysis patients and eight who had had previous problems, including two with peritonitis (one also with an ESI and outflow failure, one also had adhesions and a compartment abdomen). Both of these patients had to have the catheter removed – one due to peritonitis, the other due to adhesions and outflow failure. One patient developed peritonitis that resolved with antibiotics and did not require removal of the catheter. There was 90% catheter survival at 12 months. [12]
Twardowski et al compared 103 swan neck Missouri catheters with 148 standard catheters as historical controls (Tenckhoff and Toronto Western). The swan neck catheters had either a coiled or straight IP segment. There was no difference in the number of catheter failures due to peritonitis or ESI. The catheter survival was significantly better in the swan neck group at 3 years (64% vs 29%) than in those with standard catheters. [13]

Minguela et al reported on 105 self-locating catheters, 53 straight catheters and 15 coiled catheters that were implanted in 139 patients. There was no significant difference in the annual peritonitis rate (self-locating 0.72 ± 1.42, straight-tip 0.95 ± 2.31, coiled-tip 0.65 ± 0.86 episodes annually). There was better catheter survival in the self-locating group at 1, 2 and 3 years than the coiled- or straight-tip groups, respectively (97%, 80%, 75% at 1 year and 96%, 80%, 67% at 3 years). [14]

**SUMMARY OF THE EVIDENCE**

The systematic review from 2004 found no effect of catheter type on the outcome of peritonitis or other infectious outcome, concluding that no catheter has been shown to be better than the standard double-cuff Tenckhoff catheter at preventing peritonitis. The review also reported no difference in mechanical complications with straight versus coiled catheters but noted significant heterogeneity between trials.

Two recent randomised, controlled trials with a total of 93 and 132 patients each have shown lower technique survival with coiled-tip catheters as opposed to straight catheters, due to poor dialytic clearance in one trial and catheter migration requiring surgical revision or removal in the other. Whether these represent manifestations of the same problem (omental wrapping) remains to be proven, but the problem of higher complication rates with coiled catheters has also been found in one other recent RCT [15] although this was a very small trial (interrupted after only 24 of a target of 50 patients were recruited) in which an interim analysis revealed very high rates of catheter malposition and removal. The higher rate of technical problems with coiled catheters seems to be a consistent finding, with a potential biologically plausible explanation.

**WHAT DO THE OTHER GUIDELINES SAY?**

Kidney Disease Outcomes Quality Initiative: No recommendation.

UK Renal Association (2009):

Peritoneal Access: Guideline 5.2 - We suggest that no particular catheter type is proven to be better than another (Evidence grade 2C). [16]

Canadian Society of Nephrology: No recommendation.

European Renal Best Practice Guidelines: No recommendation.

International Guidelines: No recommendation.

**SUGGESTIONS FOR FUTURE RESEARCH**

Well-conducted, adequately powered, ideally multi-centre RCTs should be performed when new PD catheters are developed to establish whether they are of any clinical benefit.

**CONFLICT OF INTEREST**

David Mudge has a Level IIb conflict of interest according to the conflict of interest statement set down by CARI.
REFERENCES


# APPENDICES

Table 1. Characteristics of included studies

<table>
<thead>
<tr>
<th>Study ID</th>
<th>N</th>
<th>Study Design</th>
<th>Setting</th>
<th>Participants</th>
<th>Intervention (experimental group)</th>
<th>Intervention (control group)</th>
<th>Follow up (months)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson et al 2006</td>
<td>132</td>
<td>Randomised controlled trial (open label)</td>
<td>Two centres – Australia</td>
<td>Adult patients with ESKD requiring a Tenckhoff catheter for PD. The only exclusions were psychological illness or inability to provide consent.</td>
<td>Coiled double-cuffed Tenckhoff catheter</td>
<td>Straight double-cuffed Tenckhoff catheter</td>
<td>Up to 36</td>
<td></td>
</tr>
<tr>
<td>Lo et al 2002</td>
<td>93</td>
<td>Randomised controlled trial</td>
<td>Single centre – Hong Kong</td>
<td>New PD patients</td>
<td>1. Swan-neck straight catheter</td>
<td>Conventional straight double-cuffed Tenckhoff catheter</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Eklund et al 1997</td>
<td>60</td>
<td>Randomised controlled trial</td>
<td>Single centre – Finland</td>
<td>Consecutive patients for CAPD</td>
<td>Double-cuffed Tenckhoff catheter</td>
<td>Single-cuff Tenckhoff catheter</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Akyol et al 1990</td>
<td>39</td>
<td>Randomised controlled trial</td>
<td>Single centre – UK</td>
<td>Consecutive patients for CAPD</td>
<td>Curled double-cuffed Tenckhoff catheter</td>
<td>Straight double-cuffed Tenckhoff catheter</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2. Quality of randomised trials

<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>Method of allocation concealment *</th>
<th>Blinding (participants)</th>
<th>(investigators)</th>
<th>(outcome assessors)</th>
<th>Intention-to-treat analysis †</th>
<th>Loss to follow up (%)</th>
<th>Comments ‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson et al 2006</td>
<td>Sequentially labelled opaque sealed envelopes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>0%</td>
<td>(Ø)</td>
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<tr>
<td>Lo et al 2002</td>
<td>Not stated</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
<td>(−)</td>
</tr>
<tr>
<td>Eklund et al 1997</td>
<td>Sealed envelopes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>0%</td>
<td>(Ø)</td>
</tr>
<tr>
<td>Akyol et al 1990</td>
<td>Not stated</td>
<td>Yes</td>
<td>Yes</td>
<td>Unclear</td>
<td>Unclear</td>
<td>0%</td>
<td>(Ø)</td>
</tr>
</tbody>
</table>

* Choose between: central; third party (e.g. pharmacy); sequentially labelled opaque sealed envelopes; alternation; not specified.
† Choose between: yes; no; unclear.
‡ Quality score – “How successfully do you think the study minimised bias?” Choose between: very well (+); okay (Ø); poorly (−).
### Table 3a. Results for dichotomous outcomes

<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>Outcomes</th>
<th>Intervention group (number of patients with events/ number of patients exposed)</th>
<th>Control group (number of patients with events/ number of patients not exposed)</th>
<th>Relative risk (RR) [95% CI]</th>
<th>Risk difference (RD) [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson et al 2006</td>
<td>Requirement for laparoscopic repositioning of catheter</td>
<td>10/62 (coiled)</td>
<td>10/70 (straight)</td>
<td>1.13 (0.50, 2.53)</td>
<td>0.02 (-0.10, 0.14)</td>
</tr>
<tr>
<td></td>
<td>Frequency of infections</td>
<td>29/62 (coiled)</td>
<td>37/70 (straight)</td>
<td>0.88 (0.63, 1.25)</td>
<td>-0.06 (-0.23, 0.11)</td>
</tr>
<tr>
<td></td>
<td>2-year patient survival</td>
<td>49/62 (coiled)</td>
<td>62/70 (straight)</td>
<td>0.89 (0.77, 1.04)</td>
<td>-0.10 (-0.22, 0.03)</td>
</tr>
<tr>
<td>Lo et al 2002</td>
<td>ESI</td>
<td>28/45 (all swan-neck)</td>
<td>34/48 (conventional)</td>
<td>0.88 (0.66, 1.18)</td>
<td>-0.09 (-0.28, 0.11)</td>
</tr>
<tr>
<td></td>
<td>ESI</td>
<td>14/22 (curled swan-neck)</td>
<td>14/23 (straight swan-neck)</td>
<td>1.05 (0.66, 1.65)</td>
<td>0.03 (-0.26, 0.31)</td>
</tr>
<tr>
<td></td>
<td>Peritonitis</td>
<td>24/45 (all swan-neck)</td>
<td>25/48 (conventional)</td>
<td>1.02 (0.70, 1.51)</td>
<td>0.01 (-0.19, 0.22)</td>
</tr>
<tr>
<td></td>
<td>Peritonitis</td>
<td>12/22 (curled swan-neck)</td>
<td>12/23 (straight swan-neck)</td>
<td>1.05 (0.61, 1.81)</td>
<td>0.02 (-0.27, 0.32)</td>
</tr>
<tr>
<td>Eklund et al 1997</td>
<td>ESI</td>
<td>14/30 (double-cuff)</td>
<td>11/30 (single-cuff)</td>
<td>1.27 (0.69, 2.33)</td>
<td>0.10 (-0.15, 0.35)</td>
</tr>
<tr>
<td></td>
<td>Peritonitis</td>
<td>17/30 (double-cuff)</td>
<td>14/30 (single-cuff)</td>
<td>1.60 (1.07, 2.40)</td>
<td>0.20 (0.03, 0.36)</td>
</tr>
<tr>
<td>Akyol et al 1990</td>
<td>ESI</td>
<td>16 episodes/ 255 patient-months (curled)</td>
<td>21 episodes/ 266 patient-months (straight)</td>
<td>0.79 (0.42, 1.49)</td>
<td>-0.02 (-0.06, 0.03)</td>
</tr>
<tr>
<td></td>
<td>Peritonitis</td>
<td>17 episodes/ 255 patient-months (curled)</td>
<td>14 episodes/ 266 patient-months (straight)</td>
<td>1.27 (0.64, 2.52)</td>
<td>0.01 (-0.03, 0.05)</td>
</tr>
</tbody>
</table>
Table 3b. Results for continuous outcomes

<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>Outcomes</th>
<th>Intervention group (mean [SD])</th>
<th>Control group (mean [SD])</th>
<th>Difference in means (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson et al 2006</td>
<td>Technique survival</td>
<td>1.5 (1.18) years (coiled)</td>
<td>2.1 (1.26) years (straight)</td>
<td>-0.60 (-1.20, -0.18)</td>
</tr>
</tbody>
</table>