Effective immobilization of the peritoneal catheter has repeatedly been associated with positive catheter-related outcomes. This single-center retrospective community study compared infectious complication rates for peritoneal catheters that exit from a highly mobile structure (the abdomen) with rates for catheters exiting from a structure with minimal associated motion (the chest). Data were collected between January 1, 2005, and January 31, 2010.

Patients undergoing catheter implantation were divided into two groups: 22 patients with 23 abdominal catheters; 21 patients with 22 presternal catheters. The abdominal and presternal groups were similar, with the exception of catheter experience (410.4 months and 187.2 months respectively), and mean body mass index (BMI—26.2 kg/m² and 29.1 kg/m² respectively). Catheter-related infections prompted removal of 2 abdominal catheters. No presternal catheters had to be removed. For abdominal and presternal catheters respectively, the rates of exit-site infection were 0.22 episodes/patient–year and 0.11 episodes/patient–year (p = 0.73), and the incidences of peritonitis were 0.41 episodes/patient–year and 0.27 episodes/patient–year (p = 0.63).

The more effective catheter immobilization on the chest may lower the frequency of infectious complications.

**Keywords**

Presternal catheter, abdominal catheter, catheter immobilization, exit-site infection, peritonitis

**Introduction**

Effective immobilization of the peritoneal dialysis (PD) catheter has been repeatedly associated with positive catheter-related outcomes from implantation to end of lifespan. By fastening the newly implanted catheter to the skin, the surgeon lowers the exit trauma risk and ensures new tissue growth (1,2). When the dialysis nurse carefully changes the postoperative dressing, minimally manipulating the catheter and then anchoring it once again, healing of the wound and the catheter tract is promoted (3,4). Even after healing is complete, the risks of catheter complications and infections are reduced if the catheter is secured in a way that prevents tension and exit-site trauma (5). Any failure to keep the catheter secured increases the likelihood of a catheter complication (4).

Twardowski believed that a catheter would be easier to immobilize if the location of the exit site were to be moved from the highly mobile abdomen. He chose, as an alternative site, the upper anterior chest, where the subcutaneous fat layer is thin and wall motion is minimal, and he introduced a new catheter to exit there (6). In the studies that followed, Twardowski achieved a lower incidence of exit-site and tunnel infections with this “presternal” catheter (7). He attributed the improved outcomes to decreased trauma and more effective immobilization on the chest (7,8).

Our center’s persistent efforts to keep patient catheters secure have already been rewarded with improved catheter-related outcomes. Thus, this author read Twardowski’s studies with great interest. The presternal catheter appeared to be an opportunity to further capitalize on the benefits of effective catheter immobilization. Our nephrology team agreed, and in 2005, we implanted our first presternal catheter. Since that time, a similar number of abdominal and presternal PD catheters have been placed. The aim of the present study was to compare the two catheter types to see if more effective immobilization on the chest is associated with improved catheter-related outcomes.

**Patients and methods**

This nonrandomized retrospective study, conducted at a single Wisconsin community hospital, compared infectious complications associated with abdominal and presternal catheters. During the study period...
(January 1, 2005, to January 31, 2010), only the standard Tenckhoff catheter (straight, double-cuffed) and the prestenal Missouri swan-neck catheter were used. Two individual surgeons placed 61% (35% and 26%) of the abdominal catheters and 100% (68% and 32%) of the prestenal catheters.

Calculations of body mass index (BMI) were made at the time of catheter implantation. Exit-site infection (ESI) was defined as the presence of purulent drainage, with or without erythema, at the catheter exit site (9,10); and peritonitis was diagnosed in the presence of cloudy dialysate or abdominal pain (or both), with 100 or more white blood cells per milliliter of dialysate, 50% or more being polymorphonuclear cells (5,11). Infection rates are expressed as episodes per patient-year. A chi-square analysis was performed to assess the statistical significance of differences in infectious complications. Statistical significance was set at p value of 0.05.

**Results**

Abdominal catheters (n = 23) were implanted in 22 patients (10 women, 12 men; mean age: 57.6 years), and prestenal catheters (n = 22) were implanted in 21 patients (7 women, 14 men; mean age: 66.9 years). A transition from a predominance of abdominal catheters to prestenal catheters occurred. Figure 1 shows the number of abdominal and prestenal catheters implanted by year.

Figure 2 shows the mean BMI associated with each catheter type by year. Across the entire study period, the mean BMI for patients with abdominal catheters was 26.2 kg/m², as compared with 29.1 kg/m² for patients with prestenal catheters. Two patients with abdominal catheters and 8 patients with prestenal catheters had a BMI of 30 kg/m² or more. For abdominal and prestenal catheters, the total catheter experience was 410.4 months and 187.2 months respectively. The mean catheter experience was 17.1 months and 8.1 months respectively. Figure 3 presents the number of abdominal and prestenal catheters in 6-month intervals of catheter experience.

An infected superficial cuff and chronic ESI prompted the removal of 2 abdominal catheters. In both instances, a prestenal replacement catheter was implanted, allowed to heal, and used before the infected abdominal catheter was removed. No prestenal catheters required removal, although 2 catheters with superficial cuff infections were modified. The cuff of one catheter was externalized and shaved.

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**FIGURE 1** Number of abdominal and prestenal catheters implanted, by year. A transition from predominantly abdominal catheters to predominantly prestenal catheters occurs over time.
FIGURE 2  Mean body mass index (BMI) of patients with abdominal and presternal catheters, by year. The mean BMI for patients with presternal catheters exceeds the mean BMI for patients with abdominal catheters each year (no abdominal catheters were placed in 2009). The annual difference in mean BMI is greatest in 2005 when the predominant reason for selecting a presternal catheter was obesity. Mean BMI for the entire study period is higher in patients with presternal than with abdominal catheters.

FIGURE 3  Catheter experience with abdominal and presternal catheters, in 6-month intervals. Most presternal catheters are less than 1 year post implant. The 7 consecutive presternal (and 0 abdominal) catheters placed in the final 13 months of the study are partly responsible for the lower mean presternal catheter experience.
extending catheter survival for more than 1 year. (That catheter remains active.) The thoracic segment of the second catheter was replaced, and a new exit-site was created, permitting the patient to continue PD therapy.

An ESI developed with 8 abdominal and 2 presternal catheters ($p = 0.16$). Rates of ESI for abdominal and presternal catheters were 0.22 episodes/patient–year (1 episode every 45.5 months) and 0.11 episodes/patient–year (1 episode every 109.1 months) respectively ($p = 0.73$).

Peritonitis occurred with 15 abdominal and 5 presternal catheters ($p = 0.10$), at incidence rates of 0.41 episodes/patient–year (1 episode every 29.3 months) and 0.27 episodes/patient–year (1 episode every 44.4 months) respectively ($p = 0.63$). Table I summarizes the study data.

**Discussion**

This nonrandomized single-center retrospective study compared a small series of abdominal and presternal catheters to determine if more effective catheter immobilization on the chest is associated with improved catheter-related outcomes.

Although the incidence of ESI is higher in obese patients (12), and presternal BMI is higher (2 abdominal and 8 presternal catheter patients had a BMI of 30 kg/m$^2$ or more), a lower number of ESIs occurred with presternal than with abdominal catheters ($p = 0.16$). More effective catheter immobilization and decreased trauma on the chest wall may lower ESI risk.

In an interesting finding, a reduction of gram-negative peritonitis (and gram-negative ESIs) occurred in patients who applied gentamicin cream daily to the exit site, prompting Bernardini to conclude that gram-negative peritonitis may be acquired by the pericatheter route more frequently than previously thought (13). That reasoning is consistent with an earlier postulation by Burkart (2) that the healed external cuff protects against migrating bacteria and infection by restricting piston-like movements and trauma, rather than by being a physical barrier *per se*. Conceivably, more effective catheter immobilization in the upper chest may reduce the likelihood of peritonitis acquired from occult catheter infections. In the present study, peritonitis occurred less often with presternal than with abdominal catheters ($p = 0.10$).

The disparity in mean abdominal and presternal catheter experience (17.1 and 8.1 months respectively) introduces the possibility of bias into the study, given that catheter-associated infections are more likely to occur during the first post-implant year (14). When infection rates, and not frequencies, were analyzed, ESI and peritonitis $p$ values were 0.73 and 0.63 respectively. The placement of 7 consecutive presternal and no abdominal catheters in the last 13 study months lowers the mean presternal catheter experience.

### Table I Results with presternal and abdominal catheters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Presternal</th>
<th>Abdominal</th>
<th>$p$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients ($n$)</td>
<td>21</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Catheters ($n$)</td>
<td>22</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Total catheter experience (months)</td>
<td>187.2</td>
<td>410.4</td>
<td></td>
</tr>
<tr>
<td>Mean catheter experience (months)</td>
<td>8.1</td>
<td>17.1</td>
<td></td>
</tr>
<tr>
<td>Catheters implanted (in 2005/in 2009)</td>
<td>3/9</td>
<td>9/0</td>
<td></td>
</tr>
<tr>
<td>Longest catheter survival$^a$ (months)</td>
<td>44</td>
<td>55.2</td>
<td></td>
</tr>
<tr>
<td>Patients with BMI &gt; 30 kg/m$^2$ ($n$)</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Patient BMI [mean/highest (kg/m$^2$)]</td>
<td>29.1/39</td>
<td>26.2/35.4</td>
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<tr>
<td>Catheters ($n$) with</td>
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<td>Infected cuff/chronic exit-site infection</td>
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<td>1/1</td>
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<td>Subsequent catheter removal</td>
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<td></td>
</tr>
<tr>
<td>Successful catheter salvage</td>
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<td>0</td>
<td></td>
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<tr>
<td>Exit-site infections</td>
<td>2</td>
<td>8</td>
<td>0.16</td>
</tr>
<tr>
<td>Peritonitis episodes</td>
<td>5</td>
<td>15</td>
<td>0.10</td>
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<tr>
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<td>54.5</td>
<td>0.73</td>
</tr>
<tr>
<td>Peritonitis infection rate (months between episodes)</td>
<td>44.4</td>
<td>29.3</td>
<td>0.63</td>
</tr>
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</table>

$^a$ At 31 January 2010.

BMI = body mass index.
Conclusions
The presternal catheter has advantages over the abdominal catheter with regard to improving catheter-related outcomes. The present findings, although nonsignificant, are similar to results previously reported (7). Potentially, the presternal catheter may achieve for catheter immobilization what twin-bag technology and elimination of bag spiking (15) did for patient connectology. Inherent in the presternal design, a measure of immobilization is always present.

Research on immobilization is nearly nonexistent, especially as it pertains to the externalized catheter. After meticulous surgical tunneling and cuffing to effectively immobilize the internal catheter, the externalized segment is too often “secured” by a loose piece of tape, or a tuck into an undergarment. What constitutes effective catheter immobilization, and what are the best ways to achieve it? How much potential benefit can be realized if the goal of catheter immobilization is not effectiveness, but excellence? Continually across the catheter lifespan, effective catheter stabilization is strongly associated with improved outcomes. With better understanding and innovative application of immobilization characteristics to clinical practice, we can continue to improve patient outcomes. For now, selecting the location of the catheter exit-site is indeed an opportunity to capitalize on catheter immobilization.

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References

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