Data regarding the outcomes of peritoneal dialysis (PD) patients undergoing nephrectomy are limited. In the 20-year retrospective study reported here, we included patients who underwent nephrectomy and then subsequently started PD within 1 year (group A) and those who underwent nephrectomy while already on PD (group B). We examined mechanical complications including incisional hernia, peritoneal leak, and wound infection or dehiscence. Among biochemical outcomes (group B only), we analyzed serum creatinine, albumin, potassium, and phosphate for 1 year pre- and post-nephrectomy.

Among the 8 patients identified (4 in group A, 4 in group B), 7 underwent unilateral nephrectomy, and 1, bilateral nephrectomy. Surgery was laparoscopic in 1 patient and open in 7 patients. The approach was transperitoneal in 5 patients, and retroperitoneal in 3 patients. Incisional hernia occurred in 4 patients (2 in each group), and retroperitoneal leak was seen in 1 patient in group B after 2 months. No wound dehiscence or other complications occurred. In group B, 2 patients required hybrid therapy in the form of once-weekly hemodialysis with continuous ambulatory PD. Among the biochemical complications, we noted that serum creatinine increased (as expected), and serum albumin significantly declined and remained lower post-nephrectomy.

Our data show that, post-nephrectomy, PD patients have a high incidence of incisional hernia. They also experience a significant decline in serum albumin and a substantial loss in residual kidney function potentially requiring intensified dialysis. The retroperitoneal approach may on occasion predispose to retroperitoneal leak of dialysate.

**Key words**
Nephrectomy, mechanical complications

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**Introductions**
Nephrectomy is rarely performed in patients with end-stage renal disease, especially in those undergoing peritoneal dialysis (PD). Most nephrectomy data have come from urology studies and focus on the various surgical approaches and methods, the timing of PD initiation, and the hospital stay. Patients on PD having abdominal surgery may or may not have to stop PD and accordingly require temporary hemodialysis (HD). The data about outcomes in PD patients undergoing nephrectomy either before PD is initiated or after PD has been started are very limited. In this retrospective study, we analyzed the mechanical and biochemical outcomes of patients undergoing nephrectomy before or after PD initiation.

**Methods**
We reviewed all PD patients who attended the home PD program at the University Health Network in Toronto over a 20-year period. Patients were evaluated in two groups. Group A consisted of patients who underwent nephrectomy and then subsequently started PD within 1 year; group B included patients who already were on PD and who subsequently underwent nephrectomy. The latter patients either resumed PD immediately or required temporary HD as renal replacement therapy.

Surgical details such as the type of surgery (open vs. laparoscopic), the surgical approach (transperitoneal vs. retroperitoneal), and the type of nephrectomy (unilateral vs. bilateral) were noted. We analyzed the mechanical complications of nephrectomy such as incisional hernia, retroperitoneal leak, wound infection or dehiscence, and the time at which such complications appeared after PD was started (group A) or resumed (group B). Biochemical parameters analyzed pre- and post-nephrectomy (group B only) included serum creatinine, potassium, phosphate, and albumin. We averaged all laboratory blood work for the group B patients for 1 year pre- and post-nephrectomy.
Statistics
For comparing the means of the biochemical outcomes, the Student t-test was used.

Results
The 8 PD patients identified (4 in group A and 4 in group B) included 5 men and had an average age of 54.4 years (range: 41 – 70 years). The native kidney diseases leading to end-stage renal disease in these patients were autosomal-dominant polycystic kidney disease (n = 4), single kidney (n = 1), hypertension and focal segmental glomerulosclerosis (n = 1), and unknown (n = 2).

The indication for nephrectomy was renal cancer in 5 patients, pain and hemorrhage in 2 patients with polycystic kidney disease, and the need in 1 patient with polycystic kidney disease for creation of space in advance of transplantation (Table I). Nephrectomy was unilateral in 7 patients and bilateral in 1 patient. In 1 patient, the surgery was laparoscopic, and in 7 patients, it was open. The surgical approach was transperitoneal in 5 patients and retroperitoneal in 3 patients.

For group A patients, PD was initiated 1 – 8 months after nephrectomy. Three patients eventually underwent renal transplantation; 1 patient continued on PD.

Of the group B patients, 2 restarted PD on postoperative day 1, and the other 2 received HD for 2 weeks. Of the patients who restarted PD immediately (a retroperitoneal approach having been used in both), one was temporarily started on continuous cycling PD (CCPD) with a tidal volume, and the other was started on continuous ambulatory PD (CAPD). The patient who was started on CAPD on postoperative day 1 subsequently developed an incisional hernia and retroperitoneal leak, at 2 months and after 7 months had to add HD (hybrid therapy) because of decreased solute clearances. Of the patients who required post-nephrectomy HD (a transperitoneal open surgery having been used in both), one was successfully switched to PD after 2 weeks, and the other required hybrid therapy consisting of once-weekly HD with CAPD, until undergoing renal transplantation. Two patients in group B underwent renal transplantation after 8 months and 5 years. Of the remaining 2 patients, one continued on hybrid therapy, and the other remained on CCPD.

With respect to mechanical complications, 4 patients experienced incisional hernia (2 in each group). In group A, a transperitoneal approach had been used in the 2 patients with incisional hernia. In one patient the surgery was open, and in the other, it was laparoscopic. In the group B patients with incisional hernia, open surgery with a transperitoneal approach had been used in one, and open surgery with a retroperitoneal approach in the other. Retroperitoneal leak was seen in 1 group B patient 2 months after a retroperitoneal open nephrectomy. No incidence of wound dehiscence or other complication was observed in either group.

Table II shows the biochemical changes recorded in group B. Not surprisingly, residual kidney function

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>Indications for and type of nephrectomy in the study patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
<td>Overall Started PD aftera</td>
</tr>
<tr>
<td>Patients (n)</td>
<td>8</td>
</tr>
<tr>
<td>Indication</td>
<td></td>
</tr>
<tr>
<td>Malignancy</td>
<td>5</td>
</tr>
<tr>
<td>Complications of PKD</td>
<td>2</td>
</tr>
<tr>
<td>Pre-transplantation space</td>
<td>1</td>
</tr>
<tr>
<td>Nephrectomy type</td>
<td></td>
</tr>
<tr>
<td>Unilateral/bilateral</td>
<td>7/1</td>
</tr>
<tr>
<td>Laparoscopic/open</td>
<td>1/7</td>
</tr>
<tr>
<td>Transperitoneal/retroperitoneal</td>
<td>5/3</td>
</tr>
</tbody>
</table>

a Within 1 year.

PD = peritoneal dialysis; PKD = polycystic kidney disease.

<table>
<thead>
<tr>
<th>TABLE II</th>
<th>Biochemical parameters pre-nephrectomy and post-nephrectomy in the four patients already on peritoneal dialysis (average lab values of 1 year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nephrectomy</strong></td>
<td>Before</td>
</tr>
<tr>
<td>Serum creatinine (μmol/L)</td>
<td>791.7±280.7</td>
</tr>
<tr>
<td>Serum potassium (mEq/L)</td>
<td>4.77±0.39</td>
</tr>
<tr>
<td>Serum phosphorus (mmol/L)</td>
<td>1.85±0.59</td>
</tr>
<tr>
<td>Serum albumin (g/L)</td>
<td>38.45±3.5</td>
</tr>
<tr>
<td>Urine outputa (mL/day)</td>
<td>1138±1432</td>
</tr>
</tbody>
</table>

a One patient was anuric because of bilateral nephrectomies.
declined significantly after nephrectomy. We observed that, compared with pre-nephrectomy values, serum albumin declined significantly post-nephrectomy. Serum potassium and phosphorus increased after nephrectomy, but the change did not achieve statistical significance.

Discussion
Results in our small cohort suggest that incisional hernia is common in patients undergoing nephrectomy and PD. In both groups, 50% of patients experienced incisional hernia (Figure 1). Of the 2 group A patients with incisional hernia, both had undergone surgery using a transperitoneal approach. The nephrectomy was laparoscopic in one and open in the other. The incisional hernia occurred at the site of port insertion in the patient receiving laparoscopic surgery.

Currently, data about hernia after laparoscopic nephrectomy in patients on PD are sparse. Van Ramshorst et al. (1) showed that ascites is a risk factor for the development of abdominal dehiscence and incisional hernia in patients having abdominal surgery. Because PD patients resume PD or start PD de novo after nephrectomy, they are at risk of developing incisional hernias because of increased intra-abdominal pressure.

Of the 2 group B patients who experienced incisional hernia, one underwent transperitoneal open nephrectomy, and the other underwent retroperitoneal open nephrectomy. In their case study of 3 CAPD patients who underwent transperitoneal laparoscopic nephrectomy, Rais–Bahrami et al. (2) showed that, with a bridge of HD, all had re-initiated CAPD after 12.7 days. Their case series mentioned that no complications were observed for a mean follow-up of 13 months.

Retroperitoneal leak (Figure 2), a rare complication of retroperitoneal open nephrectomy, occurred in 1 group B patient. Because of the retroperitoneal leak, the patient failed to achieve adequate clearance with CAPD and hence had to start hybrid therapy with add-on HD. The diagnosis of retroperitoneal leak was suggested by diminished ultrafiltration and fluid gain in the face of an unchanged peritoneal equilibration test.

Post-nephrectomy, 2 group B patients were on HD for 2 weeks; thereafter, they were switched to PD. In a case series of 3 PD patients, Hsu et al. (3) reported that a retroperitoneal approach for radical nephrectomy allowed them to restart PD after 1 – 3 days. However their study did not mention any mechanical or biochemical complication post-nephrectomy in the 3 PD patients. Others have advocated that PD patients who are having abdominal surgery be switched to HD altogether, allowing the peritoneum to heal for 6 weeks before resuming PD (4).

Data from our analysis shows that, compared with pre-nephrectomy values, serum albumin was significantly lower in group B patients after nephrectomy. This observed decline in serum albumin may be a
result of multiple factors, including inflammation after surgery, loss of residual renal function (5), or the fact that most of our patients (3 of 4) had an underlying malignancy. But because nephrectomy was curative for malignancy in these patients and because the patients had not received any anti-neoplastic agents, malignancy was unlikely to have been an important contributor. In addition, none of the patients experienced a post-nephrectomy peritonitis that might explain the decline in serum albumin. Although not statistically significant, serum potassium and phosphorus increased after nephrectomy as a result of loss of residual kidney function, which contrasts with a finding of decreased serum creatinine and potassium in a study done immediately after CAPD was re-initiated (2).

When patients with antecedent normal renal function undergo nephrectomy, the remaining kidney undergoes dynamic compensation (known as “renal reserve”) and anatomic growth leading to hypertrophy that is able to compensate for the initial drop in glomerular filtration rate. However, when advanced kidney disease is present, the remaining damaged kidney is less able to hyperfilter, and so the patient may be left with significant and fixed loss of renal function, possibly needing more dialysis for clearance as well as for ultrafiltration. The extra clearance can be achieved by adding a day dwell to a CCPD regimen, by switching from a CCPD to a CAPD regimen, or by using hybrid therapy involving both CAPD and add-on HD.

Limitations of the present study include its retrospective nature, small number of patients, and single-center focus.

Conclusions
Our data show that, after nephrectomy, PD patients have a high incidence of incisional hernia. Not surprisingly, they also have substantial loss of residual kidney function and may need intensified dialysis. A retroperitoneal approach to surgery may predispose to the rare complication of retroperitoneal leak of dialysate. A significant decline in serum albumin that occurs after nephrectomy might be associated with loss of residual renal function.

Disclosures
JMB has been a consultant or has served on advisory boards for Takeda Pharmaceuticals, Amgen, and Baxter Healthcare. She is a member of the speakers’ bureau for DaVita Healthcare Partners and for Amgen.

References

Corresponding author:
Joanne M Bargman, MD FRCP, University of Toronto and University Health Network, Home Peritoneal Dialysis Unit, Toronto General Hospital, 200 Elizabeth Street, 8N-840, Toronto, Ontario M5G 2C4 Canada.
E-mail: joanne.bargman@uhn.ca