

# Chronic peritoneal indwelling catheters for the management of malignant and nonmalignant ascites

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## ABSTRACT

Ascites is a debilitating condition affecting patients with end-stage liver disease and advanced abdominal malignancies. Serial paracentesis can reduce symptoms in these patients; indwelling peritoneal catheters provide an alternative approach that allows patients to manage their symptoms at home. A literature search was conducted to identify studies with at least 20 patients published in the last 15 years that reported indwelling catheter placement in patients with chronic ascites. Fourteen studies with 957 patients (687 with malignancy and 270 with cirrhosis) were reviewed. Symptom improvement was reported in all studies. The most common complication in patients with malignant ascites was catheter dysfunction (39/687). Infection rates for patients with malignancy and patients with nonmalignant ascites were 5.4% (37/687) and 12.2% (33/270), respectively. Infection risk significantly increased with devices in place for >12 weeks. The average survival time after catheter placement was 7.2 weeks for patients with malignancy and 164 weeks for patients without malignancy. In conclusion, indwelling peritoneal catheters are an effective alternative to paracentesis for palliation in patients with refractory ascites. Peritonitis is a definite risk in patients with nonmalignant ascites in whom prolonged use is expected.

**KEYWORDS** Ascites; cirrhosis; complications; indwelling catheters; malignancy

Ascites is the abnormal accumulation of fluid in the peritoneal cavity that can develop in the late stages of both benign and malignant diseases. Benign ascites, which accounts for 75% to 85% of all cases, is one of the most frequent complications of liver failure and usually responds to high-dose diuretic therapy and sodium-restricted diets. However, as the patient's condition deteriorates, it can progress to refractory cirrhotic ascites (RCA) in 5% to 10% of patients, which then requires alternative treatments such as transhepatic shunts, serial large-volume paracentesis (LVP), or liver transplant to alleviate symptoms.<sup>1</sup> Malignant ascites, representing 10% to 15% of all cases, results from altered vascular permeability in primary abdominal or peritoneal metastatic cancers.<sup>2</sup> This form of ascites is usually managed with serial LVP. If left untreated, increasing ascites may contribute to the development of hyponatremia, hepatorenal syndrome, umbilical herniation, and spontaneous bacterial peritonitis and has a significant impact on the patient's quality of life.<sup>1,3</sup> However, not all forms of ascites respond to first-line therapies, not all patients are candidates for more invasive therapies such as transhepatic shunts, and serial LVPs place a great burden on patients and their caregivers. Indwelling peritoneal catheters

provide an alternative treatment approach and have been used for the palliative management of recurrent ascites in patients with end-stage malignant disease<sup>4</sup> and as an alternative to LVP for the treatment of RCA in patients who fail medical management.<sup>1,5,6</sup> Contraindications to these catheters include existing peritonitis, noncorrectable coagulopathy, and loculated ascitic fluid.<sup>4</sup> We reviewed the safety and efficacy of indwelling peritoneal catheters for the treatment and palliation of recurrent benign and malignant ascites.

## METHODS

Retrospective and prospective studies with full texts were identified using PubMed, ClinicalKey, and EMBASE databases. The last search was performed on July 1, 2017. Search terms included “malignant ascites,” “nonmalignant ascites,” “benign ascites,” “cirrhotic ascites,” “recurrent ascites,” “refractory ascites,” “ascites management,” “indwelling catheter,” “tunneled catheter,” “nontunneled catheter,” “peritoneal indwelling catheters,” and “complications.” Additional articles were found through the reference lists of included studies and background literature. Inclusion criteria for this review were the number of adult patients managed with indwelling

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catheters (at least 20 patients for each study) and the date of publication (within the last 15 years). The mean age and mean survival time were calculated by taking a weighted average based on the number of patients from studies with available data. Complication rates were calculated by taking a simple average of all total participants. Studies with incomplete data were omitted from specific calculations that required such data.

## RESULTS

Our search strategy identified 14 articles with 957 adult patients managed with indwelling peritoneal catheters<sup>5-18</sup>; 687 of these patients had malignant ascites (*Table 1*) and 270 had ascites due to nonmalignant etiologies (*Table 2*). Using studies with available data for age and sex distribution, patients with malignant ascites had an average age of 61.2 years, and 60.5% of these patients were women (225/372). Patients with nonmalignant ascites had an average age of 57.6 years, and 63.4% were men (163/257). Most studies used PleurX or Tenckhoff tunneled catheters.

The most frequent complications reported for patients with malignant ascites were catheter malfunction, including occlusion and insufficient drainage (39/687, 5.7%), peritonitis and surgical site infection (37/687, 5.4%), leakage (28/687, 4.1%), pain or discomfort (15/687, 2.2%), accidental removal (10/687, 1.5%), and cellulitis (8/687, 1.2%). The most frequent complications for patients with nonmalignant ascites were catheter-related peritonitis (33/270, 12.2%), leakage (7/270, 2.6%), and catheter malfunction (3/270, 1.1%). Major complications were very infrequent in these studies. One study reported a 2.5% incidence of renal failure in patients with indwelling catheters and a 3.0% incidence of renal failure in patients undergoing LVP.<sup>8</sup> No patient had a failed liver transplantation as a consequence of an indwelling peritoneal catheter.

Using available data for survival outcomes, the average survival time after catheter placement was 50.2 days (7.2 weeks) for patients with malignant ascites and 41 months (164 weeks) for patients with nonmalignant ascites. Approximately 50% of patients received chemotherapy after the onset of ascites and/or during catheter placement.<sup>7-9,14</sup> In one study, patients with ovarian cancer received intraperitoneal chemotherapy through the catheter.<sup>10</sup> Most patients died with the catheter in place or had it removed at the time of liver transplantation.

## DISCUSSION

The majority of patients in studies focusing on nonmalignant causes of ascites were men, reflecting the higher prevalence of cirrhosis in men than in women.<sup>5,6,18</sup> Most patients in studies reporting cohorts with malignancy were women, reflecting the prevalence of gynecologic disease in cases of malignant ascites.<sup>7-17</sup> The sex distribution was more even in studies reporting cohorts focusing on nongynecological malignancies.<sup>8</sup>

Indwelling peritoneal catheters can be placed percutaneously using a tunneled or nontunneled technique based on the type of device being used and the patient's clinical status.

Tunneled catheters are placed using a modified double-incision Seldinger technique. Tunnel directionality and orientation differed among studies.<sup>14,16-20</sup> Courtney et al reported that tunneling in a superomedial direction reduces the occurrence of ascitic leakage around the catheter.<sup>14</sup> Nontunneled catheters are placed using a single-incision Seldinger technique. Because nontunneled catheters have a higher rate of complications, including infection and dislodgement, their use is typically limited to inpatients or to patients with greatly reduced life expectancies.<sup>9,11</sup> The use of ultrasonography and fluoroscopy helps identify the optimal drainage sites and greatly reduces the risk of intraprocedural complications, such as bleeding and bowel perforation.<sup>19</sup>

Technical success is very high, with a successful catheter placement rate of 97.9% to 100% noted in the included studies. Catheter patency rates are similarly high for tunneled catheters, and relatively few of these patients require catheter intervention or removal during the respective study periods.<sup>6,8,14,17</sup> Drainage can be done at home with low complication rates after educating patients and caregivers on device operation. The frequency of drainage sessions may vary among patients, and most patients require drainage daily or every other day.<sup>4,14</sup> The average volumes range up to 2000 mL for regular drainage sessions.<sup>6,14</sup> Initial drainage volumes may be much higher, and several studies reported averages of 2850 to 8530 mL drained during the first day postimplantation.<sup>10,12,13,15,17,18</sup>

Improved symptoms were reported in all studies. Courtney et al found a significant improvement in bloating and abdominal discomfort.<sup>14</sup> Two studies collected laboratory data for patients at baseline and at set intervals after catheter placement. Mild hyponatremia was found at 4 weeks and an elevated creatinine at 12 weeks compared to baseline; these values returned to baseline values during follow-up.<sup>6</sup> Courtney et al reported no significant changes in laboratory values between baseline and 12 weeks.<sup>14</sup> Using Medicare reimbursement rates from 2013, it was reported that tunneled catheters become more cost effective than serial LVP when catheter implantation obviates the need for 10 or more LVP procedures, even after adjusting for the risk and cost of catheter dysfunction.<sup>21</sup>

For patients with malignant ascites, the most commonly reported adverse event was catheter malfunction, including occlusion and low drainage volume. These issues were usually resolved by simply flushing the device, and very few patients required catheter replacement or removal due to device malfunction. Other complications included minor pain and leakage around the catheter site, which usually resolved spontaneously over time and did not require intervention.<sup>14,17</sup> Peritonitis rarely occurred in patients with nonpancreatic malignant disease; one case was reported by Courtney et al<sup>14</sup> (1/34, 2.9%), one case was reported by Rosenberg et al<sup>9</sup> (1/40, 2.5%), and many authors reported no cases at all.<sup>7,8,10-13,15-17</sup> Infection rates were higher in patients with nonmalignant ascites; 11 cases were reported by Reinglas et al<sup>18</sup> (11/33, 33.3%) and 19 cases were reported by Kathpalia et al (19/200, 9.5%).<sup>5</sup> Kathpalia et al found a significant increase in mortality in patients with RCA secondary to end-

**Table 1. Patients with ascites associated with malignancy**

Study details	Patient demographics	Device and usage details	Complications	Survival and symptom management
<p>Lungren et al<sup>7</sup></p> <ul style="list-style-type: none"> <li>• 2013</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 188 patients (83 male)</li> <li>• Mean age 59 years</li> <li>• 175 malignant ascites</li> <li>• 13 nonmalignant ascites</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> <li>• Mean catheter in situ 60 days overall</li> <li>• Mean catheter in situ 82 days for nonmalignant cases</li> </ul>	<ul style="list-style-type: none"> <li>• 5 catheter malfunctions requiring replacement</li> <li>• 4 leakage</li> <li>• 3 cellulitis</li> <li>• 1 peritonitis in nonmalignant group</li> <li>• 1 peritonitis in malignant group</li> </ul>	<ul style="list-style-type: none"> <li>• 164 patients with catheter at death or end of follow-up period</li> <li>• Pancreatic cancer cohort had increased complication rates</li> </ul>
<p>Hicks et al<sup>8</sup></p> <ul style="list-style-type: none"> <li>• 2016</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 180 patients (105 male)</li> <li>• Mean age 65 years</li> <li>• All with pancreatic adenocarcinoma</li> </ul>	<ul style="list-style-type: none"> <li>• 64 (36%) paracentesis only</li> <li>• 116 (64%) catheter placed (108 Tenckhoff only)</li> </ul>	<ul style="list-style-type: none"> <li>• Paracentesis: 4 bacterial peritonitis, 2 leakages, 2 renal failures, 2 cellulitis, 1 bowel perforation</li> <li>• Catheter: 26 peritonitis, 8 malfunction, 5 cellulitis with sepsis, 3 renal failures, 2 bowel perforations</li> </ul>	<ul style="list-style-type: none"> <li>• Median overall survival 1.8 months after ascites development</li> <li>• Tenckhoff: mean 0.8 months survival</li> <li>• PleurX/Pigtail: mean 0.9 months survival</li> </ul>
<p>Rosenberg et al<sup>9</sup></p> <ul style="list-style-type: none"> <li>• 2004</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 107 patients total in study</li> <li>• 67 receiving large-volume paracentesis only (23 male)</li> <li>• Age range 31–85 years</li> <li>• Malignancies: 12 ovarian, 12 colorectal, 7 breast, 36 other</li> </ul>	<ul style="list-style-type: none"> <li>• Large-volume paracentesis only</li> <li>• 392 paracentesis procedures performed</li> </ul>	<ul style="list-style-type: none"> <li>• 3 bacterial peritonitis</li> <li>• 2 fluid loculations</li> </ul>	<ul style="list-style-type: none"> <li>• 59/67 patients died due to underlying disease</li> <li>• 8/67 lost to follow-up in hospice</li> </ul>
<p>Rosenberg et al<sup>9</sup></p> <ul style="list-style-type: none"> <li>• 2004</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 107 patients total in study</li> <li>• 40 receiving catheters (17 male)</li> <li>• Age range 21–81 years</li> <li>• Malignancies: 8 ovarian, 7 breast, 7 colorectal, 18 other</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> </ul>	<ul style="list-style-type: none"> <li>• 1 bacterial peritonitis</li> <li>• 1 leakage</li> <li>• 1 fluid loculation</li> </ul>	<ul style="list-style-type: none"> <li>• 26 patients died with catheter in place</li> <li>• 11 patients lost to follow-up in hospice</li> </ul>
<p>Maleux et al<sup>10</sup></p> <ul style="list-style-type: none"> <li>• 2016</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 94 patients (27 male)</li> <li>• Mean age 60.1 years</li> <li>• Malignancies: 41 gynecological, 24 hepatobiliary, 13 breast, 11 gastrointestinal, 5 other</li> </ul>	<ul style="list-style-type: none"> <li>• Tenckhoff catheter (tunneled)</li> <li>• Mean 3260 mL initial drainage after placement</li> <li>• 15 patients with metastatic ovarian cancer received intraperitoneal chemotherapy treatment (catumaxomab) via catheter</li> </ul>	<ul style="list-style-type: none"> <li>• 4 leakage</li> <li>• 2 infections</li> <li>• 2 occlusions</li> <li>• 1 insufficient drainage</li> <li>• 1 accidental removal</li> </ul>	<ul style="list-style-type: none"> <li>• 85 patients died during study period</li> <li>• 4 patients lost to follow-up</li> <li>• 3 catheters removed due to reduction in drainage volumes</li> <li>• Mean time until patient death or end of follow-up 3.41 months</li> <li>• Significantly increased median survival in patients receiving intraperitoneal catumaxomab infusions</li> </ul>
<p>Gu et al<sup>11</sup></p> <ul style="list-style-type: none"> <li>• 2016</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 78 patients (35 male)</li> <li>• Mean age 58 years</li> <li>• Malignancies: 48 gastrointestinal, 16 nonspecified, 14 unknown</li> </ul>	<ul style="list-style-type: none"> <li>• Arrow Raulerson central venous catheter kit (nontunneled)</li> <li>• Median catheter in situ period 13 days</li> <li>• Mean 8538 mL drained during total in situ period</li> </ul>	<ul style="list-style-type: none"> <li>• 7 continuous leakage</li> </ul>	<ul style="list-style-type: none"> <li>• 70/78 died during follow-up</li> <li>• Mean survival 36 days</li> <li>• Significant improvement of abdominal swelling, anorexia, constipation</li> </ul>
<p>Mercadante et al<sup>12</sup></p> <ul style="list-style-type: none"> <li>• 2008</li> <li>• Prospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 40 patients (21 male)</li> <li>• Mean age 68 years</li> <li>• Malignancies: 5 lung, 5 breast, 5 uterine, 5 stomach, 4 ovarian, 4 colon, 4 pancreatic, 3 liver, 3 gallbladder, 3 other</li> </ul>	<ul style="list-style-type: none"> <li>• Central venous catheter kit (nontunneled)</li> <li>• Mean 2850 mL drained during first 24 hours</li> <li>• Mean 8499 mL drained during entire admission</li> </ul>	<ul style="list-style-type: none"> <li>• 16 occlusions</li> <li>• 4 accidental dislodgements</li> </ul>	<ul style="list-style-type: none"> <li>• 31 died during study</li> <li>• Mean survival 38.9 days</li> <li>• 22 patients reported symptom improvement</li> </ul>

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**Table 1. Patients with ascites associated with malignancy (Continued)**

Study details	Patient demographics	Device and usage details	Complications	Survival and symptom management
<ul style="list-style-type: none"> <li>Narayanan et al<sup>13</sup></li> <li>• 2014</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 38 patients (21 male)</li> <li>• Mean age 60.6 years</li> <li>• Malignancies: 10 pancreatic, 7 breast, 6 hepatocellular, 5 colorectal, 5 cholangiocarcinoma, 5 other</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> <li>• Mean 3735 mL drained during first 24 hours</li> </ul>	<ul style="list-style-type: none"> <li>• 3 pain</li> <li>• 2 infections</li> <li>• 2 leakage</li> <li>• 2 catheters removed due to insufficient drainage</li> <li>• 1 accidental catheter removal</li> <li>• 1 sleep disturbance</li> </ul>	<ul style="list-style-type: none"> <li>• Mean survival 40.7 days</li> </ul>
<ul style="list-style-type: none"> <li>Courtney et al<sup>14</sup></li> <li>• 2008</li> <li>• Prospective</li> <li>• Multicenter</li> </ul>	<ul style="list-style-type: none"> <li>• 34 patients (13 male)</li> <li>• Mean age 64.3 years</li> <li>• Malignancies: 7 pancreatic, 6 breast, 5 colon, 3 neuroendocrine, 3 ovarian, 2 liver, 1 gastrointestinal stromal tumor, 1 mesothelioma, 6 nonspecified</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> <li>• 1200–2000 mL drained every 1–2 days</li> </ul>	<ul style="list-style-type: none"> <li>• 7 leakage</li> <li>• 5 temporary dizziness/weakness after drainage</li> <li>• 4 catheter occlusions</li> <li>• 1 peritonitis</li> <li>• 1 pain during drainage</li> <li>• 1 bloody drainage and anemia requiring transfusion</li> </ul>	<ul style="list-style-type: none"> <li>• 29/34 functional catheters in place at patient death or at end of follow-up</li> <li>• 26/34 patients died during follow-up (median survival 30 days)</li> <li>• 83%–100% of patients reported having well-controlled ascites at weekly follow-ups</li> <li>• Significant improvement of abdominal discomfort</li> </ul>
<ul style="list-style-type: none"> <li>Tapping et al<sup>15</sup></li> <li>• 2012</li> <li>• Prospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 28 patients (7 male)</li> <li>• Mean age 61 years</li> <li>• Malignancies: 10 gynecological, 7 gastrointestinal, 5 pancreatic, 3 lung, 3 breast</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> <li>• Mean 5000 mL drained during first 24 hours</li> <li>• Mean catheter in situ period 113 days</li> </ul>	<ul style="list-style-type: none"> <li>• 5 discomfort with erythema and discharge</li> <li>• 4 accidental dislodgements</li> <li>• 1 leakage</li> <li>• 1 incision site hernia</li> </ul>	<ul style="list-style-type: none"> <li>• 24/28 (86%) of original catheters in place at death</li> </ul>
<ul style="list-style-type: none"> <li>O'Neill et al<sup>16</sup></li> <li>• 2001</li> <li>• Prospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 24 patients</li> <li>• Age not specified</li> <li>• Malignancies: 14 ovarian, 6 pancreatic, 2 lung, 1 thymoma, 1 renal cell carcinoma</li> </ul>	<ul style="list-style-type: none"> <li>• Polymeric silicone catheter (tunneled)</li> </ul>	<ul style="list-style-type: none"> <li>• 3 bacterial peritonitis</li> <li>• 1 bacterial peritonitis with tunnel infection requiring catheter removal</li> </ul>	<ul style="list-style-type: none"> <li>• All patients reported symptom relief until death</li> <li>• Mean survival 7.2 weeks</li> <li>• Catheters present in 23 patients at death</li> </ul>
<ul style="list-style-type: none"> <li>Meier et al<sup>17</sup></li> <li>• 2015</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 20 patients (6 male)</li> <li>• Median age 62.5 years</li> <li>• Malignancies: 6 ovarian, 4 breast, 3 pancreatic, 2 bile duct, 5 other</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> <li>• Median 5000 mL drained in first 24 hours</li> </ul>	<ul style="list-style-type: none"> <li>• 6 transient soreness</li> <li>• 2 leakage</li> <li>• 1 dislocation</li> </ul>	<ul style="list-style-type: none"> <li>• 17 patients died during study period</li> <li>• Median survival 27 days</li> <li>• Catheters in place for all patients at death or at end of follow-up period</li> </ul>

**Table 2. Patients with ascites associated with cirrhosis**

Study details	Patient demographics	Device and usage details	Complications	Survival and symptom management
<ul style="list-style-type: none"> <li>Kathpalia et al<sup>5</sup></li> <li>• 2015</li> <li>• Retrospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 200 patients (128 male)</li> <li>• Mean age 57 years</li> <li>• Refractory cirrhotic ascites due to alcohol, hepatitis C, combination of the two, "other"</li> </ul>	<ul style="list-style-type: none"> <li>• Catheter type not specified</li> </ul>	<ul style="list-style-type: none"> <li>• 19 patients developed bacterial peritonitis within 72 hours of catheter placement</li> </ul>	<ul style="list-style-type: none"> <li>• Significant increase in mortality in patients who developed peritonitis within first 72 hours</li> </ul>
<ul style="list-style-type: none"> <li>Reinglas et al<sup>18</sup></li> <li>• 2016</li> <li>• Prospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 33 patients (19 male)</li> <li>• Mean age 62 years</li> <li>• Refractory cirrhotic ascites due to alcohol (12), hepatitis C (7), nonalcoholic steatohepatitis (7), alcohol and hepatitis C (4), cardiogenic (3)</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> <li>• Mean 8.53 L initial drainage</li> <li>• Mean catheter in situ period 117.5 days</li> </ul>	<ul style="list-style-type: none"> <li>• 11 catheter-related spontaneous bacterial peritonitis</li> <li>• 6 non-catheter-related spontaneous bacterial peritonitis</li> <li>• 7 leakage from catheter site</li> <li>• 3 catheter occlusions</li> <li>• 1 hematoma</li> </ul>	<ul style="list-style-type: none"> <li>• 9 patients died during follow-up period</li> <li>• 90% catheter patency rate</li> <li>• Infection risk increased with catheters in place for &gt;3 months</li> </ul>
<ul style="list-style-type: none"> <li>Solbach et al<sup>6</sup></li> <li>• 2017</li> <li>• Prospective</li> <li>• Single center</li> </ul>	<ul style="list-style-type: none"> <li>• 24 patients (16 male)</li> <li>• Mean age 57 years</li> <li>• Refractory cirrhotic ascites due to alcohol (10), viral (6), other (8)</li> </ul>	<ul style="list-style-type: none"> <li>• PleurX catheter (tunneled)</li> <li>• Mean 1909 mL drainage daily</li> <li>• Mean catheter in situ period 83.2 days</li> </ul>	<ul style="list-style-type: none"> <li>• 3 catheter occlusions</li> <li>• 2 bacterial peritonitis</li> <li>• 1 intraabdominal pain</li> </ul>	<ul style="list-style-type: none"> <li>• 20 patients had catheters in place until death, receiving transplant, or at end of follow-up</li> <li>• Mean survival 93 days for patients not receiving liver transplant</li> </ul>

stage liver disease who developed bacterial peritonitis (BP) following catheter placement (50% mortality at 5 months with BP vs 50 months without BP).<sup>5</sup> Additionally, when compared to cohorts of patients with malignant disease, higher rates of infection occurred in patients with RCA with tunneled catheters (5.4% infection in malignant ascites vs 12.2% in benign ascites). This difference may be due to several factors, including a propensity for BP in end-stage liver disease regardless of catheter implantation and a difference of device in situ time, which is typically much longer in patients with RCA.<sup>3,5,6,14</sup> Reinglas et al reported that infection risk is significantly increased in patients with RCA whose catheters remain in place for >3 months.<sup>18</sup>

In contrast, catheter type and implantation technique may have a larger impact on survival outcomes in diseases with longer survival times. Catheter-related infections were much higher (13/30, 43.3%) in patients with malignancy managed with nontunneled catheters. High rates of other complications, such as catheter blockage (30%) and leakage (20%), also occurred in the same cohort.<sup>22</sup> Other studies have reported that nontunneled catheters also had much higher rates of unresolvable dysfunction requiring catheter replacement or removal (26%).<sup>20,23</sup> Although tunneled catheters had fewer adverse events than nontunneled catheters, Hicks et al did not find a significant difference in average survival time after implantation in patients with pancreatic adenocarcinoma based on the type of catheter used (0.8 months for tunneled vs 0.9 months for nontunneled).<sup>8</sup>

Lungren et al reported that pancreatic malignancy was associated with a significantly increased rate of complications.<sup>7</sup> Patients with pancreatic cancer accounted for only 12% (22/188) of patients reported in their study but accounted for 35.7% (5/14) of all complications in the entire study cohort, including 80% of cases (4/5) of device malfunction requiring full catheter replacement.<sup>7</sup> This same observation was apparent in the data reported by Hicks et al.<sup>8</sup> Their cohort, which included 116 patients with pancreatic adenocarcinoma with indwelling catheters, accounted for 16.9% (116/687) of all patients with malignancy summarized in this review.<sup>8</sup> However, this same cohort accounted for 70.3% (26/37) of all cases of peritonitis, 62.5% (5/8) of all cases of cellulitis, and 20.5% (8/39) of all cases of catheter malfunction in patients with malignancy.

In summary, our review suggests that tunneled indwelling peritoneal catheters provide a relatively safe and cost-effective alternative to serial LVP in most patients with recurrent malignant ascites. These devices have high rates of patency and low rates of infection and dysfunction when patients are chosen carefully and when the catheter is placed appropriately. In addition, the ability to easily drain adequate volumes of ascitic fluid at home obviates the need for patients and caregivers to make frequent appointments for repeated LVP procedures. However, clinicians should be aware of an increased risk of peritonitis in long-term use, especially for >3 months, and

these catheters should not be used as primary therapy in patients with chronic ascites.

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## Avocations



Red columbine. Photo © Rolando M. Solis, MD (rmsolis@mac.com), an interventional cardiologist at The Texas Heart Hospital Baylor Plano, The Texas Heart Hospital Baylor Denton, Baylor University Medical Center, and Baylor Heart and Vascular Hospital.