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Indwelling catheters for the management of malignant ascites

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Abstract Paracentesis is widely employed for palliation of symptomatic malignant ascites. In some patients, there is rapid re-accumulation of fluid necessitating frequent repeat procedures. Indwelling peritoneal drainage catheters can provide more durable symptom relief, avoiding the hazards and disadvantages of multiple repeat procedures. The goal of our study was to evaluate the technical success, complications and outcome associated with the use of these drainage catheters. We carried out a retrospective review of all patients who had indwelling catheters inserted for the management of symptomatic malignant ascites over a 4-year period. A total of 45 catheters were inserted in 38 patients. Insertion was technically successful in all patients, with immediate symptomatic relief. However, 2 cases of fatal hypotension were encountered in the first 24 h after catheter insertion (acute catheter-related mortality rate of 4.4%). These were attributed to rapid drainage of peritoneal fluid, although gastrointestinal tract bleeding was contributory in the second patient. Eight patients were lost to follow-up. Of the remaining 30, 13 (35.1%) patients developed catheter-related sepsis. The rate of infection was 1.6 episodes per 100 catheter-days. Thirteen tubes were removed prematurely, 6 (16.2%) due to sepsis, 5 (13.5%) because of tube blockage and 2 (5.4%) because of loculated ascites. The median length of time for which catheters were functional was 37 days (95% CI 14.1–59.6), with an average daily drainage of 539.5 ml (range 18–4000 ml). In conclusion, indwelling peritoneal drainage catheters provide a useful alternative to paracentesis in the management of symptomatic malignant ascites. Although it avoids the need for repeated paracentesis, it is not without risks. We discuss and propose some precautions to be observed in the use of these catheters.

Key words Malignant ascites · Advanced cancer · Paracentesis · Peritoneal catheter

Introduction

The problem of malignant ascites in patients with advanced cancer is well recognised. It can lead to pain from abdominal distension, respiratory difficulty from diaphragmatic splinting, and restricted mobility. Paracentesis plays an important palliative role in patients who have failed medical therapy [2, 6, 18, 22]. A survey in Canada ranked paracentesis as the most popular and effective means of managing malignant ascites [15]. Although it can hardly be described as the 'gold standard', its ability to relieve symptoms rapidly led Parsons et al. to regard it as the method against which all new treatments must be compared [16]. Rapid accumulation of fluid in some patients results in a short duration of symptom relief, however, which necessitates frequent repeat drainage procedures.

Although the idea of implanting a long-term indwelling abdominal drain is not new, there are scant data in world literature documenting the safety and efficacy of such a technique. To the best of our knowledge, there has been only one previous report, by Belfort et al. [3], who used a Silastic drain and clamping device to achieve controlled long-term drainage of malignant ascites. In our institutions, we have been using proprietary self-retaining catheters for the management of these patients. A retrospective study was conducted to evaluate the technical success, complications and outcome associated with their use.

Patients and methods

All patients who had indwelling catheters inserted for the management of symptomatic malignant ascites between April 1993 and March 1997 were included in the study. The medical records were retrospectively reviewed. Patient's particulars, type of primary malignancy, indications for catheter drainage, relevant comorbid conditions, amounts of fluid removed, complications and outcomes were recorded. Patients were followed up until death or tube removal.

Catheter insertion

Cope-type loop (Cook, Bloomington, Ind.) drainage catheters were initially developed for percutaneous drainage of the urinary and biliary systems. These are made of polyurethane and are self-retaining upon locking of the pigtail loop. They have multiple side-holes in addition to an end-hole, which allow for improved drainage and decreases the risk of catheter blockage. An 8.5-F or 10.2-F catheter was usually used.

All catheters were inserted in the interventional suites of the radiology department with strict aseptic techniques observed. A coagulation screen, comprising of platelet count, prothrombin time (PT) and activated partial thromboplastin time (aPTT), was performed prior to the procedure. PT values more than 3 s above control, a PTT more than 6 s greater than control, and platelet counts of less than 100,000/ml were considered abnormal. In these instances, fresh-frozen plasma or platelet transfusions, respectively, were given immediately before the procedure. Neither prophylactic antibiotics nor peri-procedural sedation was routinely given.

The procedure was done with the patient supine. The most commonly used sites for puncture were the iliac fossae and the hypogastrium. After infiltration of the skin and subcutaneous tissues with local anaesthetics, a small skin incision was made and an 18-G sheathed needle inserted. Fluoroscopy was previously used occasionally, but more recently, real-time ultrasound has been employed exclusively for image guidance. The location of the needle tip within the peritoneal cavity was confirmed with aspiration of ascitic fluid. The flexible end of a 0.035-in. Teflon guidewire was then advanced through the cannula into the peritoneal cavity. The cannula was later removed and serial dilatation of the percutaneous tract performed over the guidewire. This was followed by introduction of the Cope drainage catheter, with its metal stiffener, over the guidewire. The guidewire, together with the metal stiffener, was removed and small amounts of low osmolar nonionic contrast medium injected through the catheter. This served to confirm its position and also to document loculation of ascites if any. If the location of the catheter was deemed optimum, the pigtail loop was formed and the catheter was connected to a standard 2-l Foley catheter bag, allowing for free external drainage of ascitic fluid.

Catheter complications

Technical failures were defined as the unsuccessful insertion of a catheter at any one attempt. In the immediate post-procedural period, vital signs were monitored to detect hypotension. Complications such as perforation of any viscus, puncture site haematoma, or haemorrhage requiring transfusion were considered acute complications. Delayed complications such as tube blockage, dislodgement or slippage of catheter and sepsis were also noted. A tube was considered blocked if there was no drainage in the presence of clinically detectable ascites and if resistance was encountered upon injection of 10–20 ml of sterile saline. If the blockage persisted despite irrigation with normal saline, salvage of the catheter was attempted by passage of a guidewire through the catheter or by repositioning of the catheter. Sepsis was diagnosed when there was evidence of abdominal wall cellulitis and/or peritonitis which was defined as fever, leucocytosis and increase in ascitic fluid cell count (>400 granulocytes/ml) with or without a positive bacterial culture. In the absence of a positive bacterial culture, other sources of sepsis were excluded by a review of the clinical notes and relevant investigations.

Catheter end-points

Records of daily drainages of fluid were noted. The end-point of a catheter was defined as its removal from the patient. The date of and reason for removal of the catheter were recorded. Reasons for removal of tubes were classified as (1) minimal drainage with functioning catheter (purpose accomplished); (2) complications; (3) death; and (4) other.

Statistical analysis

Cumulative probabilities of catheter patency and freedom from infection including 95% confidence intervals (CI) were calculated using the Kaplan-Meier method. Catheters that were removed because of minimal residual ascites or were still in situ when the patient died were classified as censored events when the probability of catheter survival was computed. In assessment of the freedom of a catheter from infection, the first day with symptoms was deemed the start of infection.

Results

During the study period, a total of 45 drainage catheters were inserted in 38 patients for the palliation of malignant ascites, with 7 patients each having two catheters inserted on separate occasions. There were 15 men and 23 women, whose ages ranged from 27 to 70 years (mean 51.7 ± 12.9 years). All patients were symptomatic and had proven disseminated malignancy with ascites. None of the patients were following any

Table 1 Distribution of primary tumour ($n = 38$)

Tumour site	Frequency (%)
Stomach	9 (23.7)
Colorectal	9 (23.7)
Ovary	9 (23.7)
Pancreas	2 (5.2)
Other	6 (15.8)
Unknown	3 (7.9)

Table 2 Reasons for catheter removal ($n = 37$)

Reason	No. (%)
Still functional	
Fatal hypotension	2 (5.4)
Non-catheter-related death	13 (35.1)
Persistent minimal drainage (ascites resolved)	8 (21.6)
Patient's request	1 (2.7)
Other	
Sepsis	6 (16.2)
Blockage (not overcomed by flushing)	5 (13.5)
Loculation	2 (5.4)

chemotherapeutic regimen at the time of study. One patient was receiving diuretics, and 12 patients had previously failed a trial of diuretics. Diuretics were not prescribed in the rest of the patients. Gastrointestinal (stomach, colorectal) and ovarian malignancies were the primary tumours in three-quarters of our patients (Table 1). Eight patients were lost to follow-up after a mean duration of 5.4 days (SD = 4.3). These 8 patients were therefore excluded from our computation of delayed complications and from our life-table analysis, which were based on 37 catheters inserted into 30 patients.

Insertion of the catheters was technically successful in all cases, with all patients reporting immediate improvement in symptoms. No immediate complication such as perforation of a viscus or excessive bleeding was encountered during tube placement. There were, however, 2 cases of fatal hypotension (acute catheter-related mortality rate of 4.4%, $n = 45$) in the initial period following the procedure. The first patient was a 52-year-old lady with advanced cervical cancer. Her preprocedural performance status was grade 2 on the ECOG (Eastern Co-operative Oncology Group) scale, and her blood pressure at that time was 100/60 mmHg. Within the first hour of catheter insertion, 3.1 l of fluid was drained. She was found to be in a state of shock at the postprocedural review 2 h later and died despite attempts at resuscitation. The second patient was a 70-year-old lady with ovarian carcinoma. Her preprocedural performance status was ECOG grade 3. She was noted to be hypotensive the morning after catheter insertion. Four litres of ascitic fluid had been removed through the peritoneal catheter in the preceding 24 h. She was also reported to have concomitant coffee-ground vomitus, however. Neither patient was being treated with diuretics. An electrocardiogram did not reveal any evidence of myocardial infarction. Post-mortem examinations were not performed on either patient.

On follow-up, 21 (56.7%) catheters were removed electively because they were no longer required, whilst 13 (35.1%) were removed prematurely (Table 2). One patient requested removal of the catheter after 3 days because of perceived inconvenience. However, he subsequently agreed to have a second catheter inserted owing to accumulating ascites and distressing symptoms. The total number of catheter-days was 806 days. The average daily volume of fluid drained was 539.5 ml (range 18–4000). From life-table analysis, the cumulative probability and 95% CI of catheter survival at 1 week was 0.92 (95% CI 0.83–1), 0.85 (95% CI 0.73–0.97) at 2 weeks and 0.63 (95% CI 0.44–0.82) at 1 month. The median time for which catheters remained functional was 37 days (95% CI 14.4–59.6).

A total of 13 catheter-related infectious episodes (35.1%) involving 13 patients was encountered in our cohort (details in Table 3). None had bacteraemia. All patients were given empirical courses of antibiotics comprising of a cephalosporin with or without cloxacillin until the results of the ascitic fluid cultures (if carried out) were known, after which the antibiotics were adjusted accordingly. Six of the 13 catheters (16.2%) had to be removed as a result of infection. All the patients who died with the catheter in situ had progressive illness, and none could be attributed to catheter-related sepsis. The rate of infection was 1.6 episodes per 100 catheter-days, and the probability of freedom from infection and 95% CI was 0.94 (95% CI 0.86–1.0) at 1 week, 0.82 (95% CI 0.68–0.97) at 2 weeks and 0.64 (95% CI 0.45–0.84) at 1 month. The median time for which catheters were indwelling before the onset of symptomatic infection was 42 days (95% CI 17.6–66.4).

There were 11 episodes of tube blockages (29.7%), involving 9 catheters in 8 patients, including 2 catheters in 1 patient that were blocked twice. Patency was restored by flushing the catheters on 5 occasions. In another 5 instances, the catheters were removed. In 2 of these patients, the catheters were exchanged for new ones over a guidewire. The other 3 patients were then relatively asymptomatic, and a new tube was deemed not necessary. In the last case, no attempt was made to flush or readjust the tube as the patient was near death. The catheter, when it was finally removed, was found to be encrusted with tumour. The median length of time for which catheters were in situ before blockage was encountered was 24.7 days (range 6–45 days) and

Table 3 Details of catheter-related sepsis (*MRSA* methicillin-resistant*Staphylococcus aureus*;*MBG* mixed bacterial growth)

Patient no.	Age	Sex	Primary	Days to onset of sepsis	Type of infection	Ascitic fluid culture	Comments
1	65	F	Colon	48	Peritonitis with cellulitis	*Staph. aureus*	Catheter removed because of ongoing sepsis despite use of antibiotics
2	59	M	Colon	13	Peritonitis	Group B *Streptococcus*; repeat culture yielded MBG	Catheter was blocked at onset of fever. Manual flushing and aspiration successful in establishing patency. Died 2 days later from progressive disease with catheter in situ
3	56	F	Colon	32	Peritonitis	*E. coli*	Catheter removed because of sepsis
4	49	F	Stomach	15	Peritonitis	MRSA; *Streptococcus*; *Acinetobacter baumannii*	Catheter removed because of sepsis
5	28	F	Stomach	13	Peritonitis	*Acinetobacter baumannii*	Died of progressive disease with catheter in situ the following day
6	63	F	Ovary	17	Peritonitis with cellulitis	*Pseudomonas aeruginosa*	Catheter removed because of sepsis
7	70	F	Pancreas	13	Peritonitis	*Acinetobacter baumannii*	Clinical response to antibiotics. Tube was left in situ until dranage became minimal
8	46	M	Stomach	5	Peritonitis	Enterococcus	Catheter left in situ despite sepsis, because of large volume output and distress from distension
9	53	F	Ovary	42	Peritonitis	*Staphaureus*; *Acinetobacter baumannii*	Catheter removed because of sepsis
10	65	F	Ovary	12	Peritonitis	*Acinetobacter baumannii*	Catheter removed because of sepsis
11	51	F	Stomach	44	Peritonitis	MRSA; *Pseudomonas aeruginosa*	Died of progressive disease with catheter in situ
12	62	F	Ovary	16	Peritonitis	Not carried out	Clinical response to antibiotics
13	27	M	Bladder	5	Peritonitis	Not carried out	Clinical response to antibiotics

the rate of blockage was 1.4 episodes per 100 catheter-days.

Two catheters in 2 patients were removed because the ascites had become loculated (5.4%) and the tubes were no longer effective in draining the ascites. Loculation was proven with either contrast study or radionuclide imaging in these patients. The contrast or tracer pooled at the tip of the catheter and failed to mix freely with residual ascitic fluid. One of these 2 patients was still symptomatic and had a second tube inserted into a large residual collection. The other patient was comfortable and did not require insertion of a new catheter.

Seven patients (7 catheters, 18.9%) had leakage of fluid around the tube. This was remedied by an extra stitch applied at the puncture site. No appreciable increase in exit site infection was noted amongst these patients.

Discussion

Malignant ascites is a common problem in patients with advanced cancer [19] and accounts for numerous symptoms encountered by the terminally ill. With the prompt relief of symptoms it brings, it is not surprising that paracentesis has been so widely accepted. However, rapid re-accumulation of ascites means that the relief obtained with paracentesis is only temporary, necessitating frequent repeat procedures. This multiplies the risk of complications and increases the cost to the patient. The use of long-term indwelling drainage catheters in these patients is a logical progression of paracentesis. Belfort [3], in an earlier study, demonstrated its feasibility, using a specially designed catheter. Our present study provides an independent review of the results of this procedure using commercially available catheters and suggests technical improvements.

We were successful in inserting these catheters in all our patients. Placement of these peritoneal drainage catheters is technically not difficult and is safer than blind bedside paracentesis, where bowel perforation had been reported [2]. We encountered no technical complications related to the procedure. This was partly related to the use of real-time imaging during the insertion of these catheters. Peritoneal tumour deposits and the bowel could therefore be avoided. In addition, imaging also enabled detection and localisation of loculated fluid, a problem not uncommonly encountered in malignant ascites.

Although drainage of massive ascites can often be gratifying, hypotension from a large volume loss can be potentially life threatening. This has not been a problem in many reported series [3, 6]. We, however, encountered 2 deaths in the early postprocedural period as a result of hypotension. In 1 patient, 3.1 l of fluid was removed within the first hour after catheter insertion. The cause of hypovolaemia in the second patient was more contentious, as she also had concomitant gastrointestinal bleeding. Hypotension in this patient could not therefore be attributed solely to excessive catheter drainage of ascites. If the latter patient is also included in our calculations, our catheter-related mortality rate is 4.4%, which is slightly higher than that reported by Ross [18] and Appelqvist [2], who quoted rates of 1.6% and 3.2%, respectively. Our experience has caused us to be less cavalier when removing ascites, especially if it is massive. We have hence implemented the following precautionary measures in our institution. Following insertion of the catheters, some fluid is allowed to drain so as to provide immediate relief of symptoms. The volume removed is carefully charted or left in the drainage bag so that it can be accounted for subsequently. The tube is clamped during transfer from the radiology suite to the ward, as large volumes can be unknowingly removed if the patient is left unattended and there is a delay in transport. The use of a graduated clamp instead of an on/off device has also helped control the rate of fluid removal and prevent sudden rapid fluid loss. In patients with tense ascites, the high tension in the peritoneal cavity can result in rapid drainage, and this fluid shift may potentially lead to intravascular fluid loss and hypotension. We advocate the use of colloids such as Hemaccel (Emagel 3.5%, Behringwerke, Marburg, Germany), given at a rate of 150 ml per litre of ascites drained [20] for patients draining large volumes (more than 3 l/day) and for those whose blood pressure is low normal (SBP 95–105 mmHg). It is possible that the supplemental use of colloid may enable more rapid drainage to be performed safely in patients with tense malignant ascites, in a fashion analogous to total large-volume paracentesis in patients with liver cirrhosis. However, this awaits confirmation in prospective studies.

Blocked catheters and infection were the most common delayed complications encountered in our patients. There were 11 episodes of tube blockages involving 9 catheters at a rate of 1.4 episodes per 100 catheter days. It is likely that obstruction of catheters is a function of the length of time catheters are left in situ. In our study, the median time for which catheters were indwelling before becoming blocked was slightly more than 3.5 weeks. Although catheter blockages sometimes responded to flushing, about half of the blocked catheters had to be removed or replaced. Catheter blockage due to tumour overgrowth is not always preventable. It helps, however, if they are sited away from peritoneal deposits. Cross-sectional imaging has been shown to be useful in this regard [7]. Obstruction of catheters by protein encrustation can be avoided, or at least diminished, by frequent irrigation of the catheter with normal saline. This however increases the risk of peritonitis if there is a breach of aseptic techniques.

Thirteen of 37 catheters (35.1%) in our series were infected, resulting in premature removal of 6 of these catheters (16.2%). The median time for which catheters were indwelling before they became infected was 6 weeks. Belfort's experience was similar [3]. Eight of his 17 patients (47%) had culture-positive peritoneal fluid, with 2 catheters (11.8%) removed as a result of sepsis. The high rate of infection in these patients is not unexpected. Ascitic fluid provides a rich culture medium, and the presence of a drainage catheter opens a port for bacteria to enter the peritoneal cavity. Furthermore, these patients are often immunocompromised and very ill. In comparison, patients undergoing continuous ambulatory peritoneal dialysis (CAPD) do much better, with infection rates of only 1.0–1.3 episodes per year (about 0.27–0.36 episodes per 100 days) [8, 9]. It might be argued that these two groups of patients are very different and not comparable, but the marked discrepancy in rates of infection and catheter survival can serve to stimulate thought, ingenuity and improvements in technique and care, so as to narrow the gap.

To minimise infection, the importance of a strict aseptic technique during catheter insertion and maintenance of a closed drainage system cannot be overemphasised. Flow rates are controlled by means of external regulators without disconnecting the system. Fluid is drained from ports attached to the 2-l catheter bags. It has also been suggested that prophylactic antibiotics be used during catheter insertion [3]. Studies in patients with peritoneal dialysis catheters show a trend towards decreased sepsis and catheter loss with prophylactic antibiotics given before or at the same time as catheters are placed [8, 21]. It is highly possible that the same holds true for drainage catheters in malignant ascites. Meticulous local care, including measures to prevent trauma, also helps to keep the exit site healthy and free of infection [13]. The Cope loop catheter that we use is self-retaining and is not usually immobilised with sutures. We have noticed, however, that the tube does slip a couple of centimetres in and out of the peritoneal cavity. Under these circumstances, the catheter might conceivably transport surface organisms into the peritoneal cavity and precipitate peritonitis. We therefore now advocate that the catheter be anchored to the skin with a suture.

As a result of this review of our catheters, we have begun to implement some changes. Whether these pro-

Table 4 Contraindications to peritoneovenous shunt

1	Estimated prognosis <1 month
2	Ascitic fluid cytology positive
3	Ascitic fluid granulocyte count >400/ml
4	PT >4 s prolonged
5	Serum bilirubin >100 μmol/l
6	GI malignancy
7	Sepsis
8	Congestive cardiac failure
9	Significant pleural effusion

posed changes can lead to improvements in catheter function and decrease complications remains to be seen. Perhaps future trials comparing some of these different techniques can help find the optimum approach to use of these catheters.

Despite its drawbacks, the use of these indwelling catheters offers several advantages over conventional paracentesis. The need for and therefore increased risks accompanying frequent repeated punctures are avoided. We have also successfully taught our patients to care for their catheters at home, thus avoiding prolonged hospital stays and alleviating the financial burden upon the patient. The catheters are soft and flexible, allowing them to remain in situ for long periods of time without much discomfort. The tubes can be clamped with the regulator when drainage is not desired or convenient. The catheter can then be coiled up and the drainage bag tucked away under the patient's clothing. Furthermore, the complication rates of these long-term peritoneal drainage catheters compare favourably with that of peritoneovenous shunting, the other alternative in patients with intractable ascites. These shunts have reported complication rates between 18% [4] and 25% [12], and the complications include pulmonary embolism, pulmonary oedema, disseminated intravascular coagulation, thrombosis of the superior vena cava and tumour dissemination [14]. Such shunts are also known to have a high rate of blockages [5, 10], requiring revision in as many as 18% of patients [5].

Given the wide variety of treatment options available for management of this disorder, patient selection remains the key to successful management. Patients with massive hepatic metastases tend to behave more like cirrhotic patients with raised serum renin and high serum–ascites albumin gradient. These patients tend to respond better to diuretics than do patients with other forms of malignant ascites [1, 11, 17]. The use of indwelling catheters may be the treatment of choice in patients with diuretic-resistant tense ascites, who are not candidates for peritoneovenous shunt (Table 4) and require repeated paracentesis for symptomatic relief. Further prospective studies are required to compare paracentesis, long-term indwelling catheter placement, medical therapy (diuretics and analgesics) as well as peritoneovenous shunting and their impact on symptom control and quality of life.

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References

1. Akriviadis EA, Kapnias D, Hadjigavriel M, Goulis J (1996) Serum/ascites albumin gradient: its value as a rational approach to the differential diagnosis of ascites. Scand J Gastroenterol 31:814–817
2. Appelqvist P, Silvo J, Salmela L, Kostiainen S (1982) On the treatment and prognosis of malignant ascites: is the survival time determined when the abdominal paracentesis is needed? J Surg Oncol 20:238–242
3. Belfort MA, Stevens PJd'E, DeHaek K, Soeters R, Krige EJ (1990) A new approach to the management of malignant ascites; a permanently implanted abdominal drain. Eur J Surg Oncol 16:47–53
4. Cheung DK, Raaf JH (1982) Selection of patients with malignant ascites for a peritoneovenous shunt. Cancer 50:1204–1209
5. Edney JA, Hill A, Armstrong D (1989) Peritoneovenous shunts palliate malignant ascites. Am J Surg 158:598–601
6. Fischer DS (1979) Abdominal paracentesis for malignant ascites. Arch Intern Med 139:235
7. Goerg C, Schwerk W (1991) Peritoneal carcinomatosis with ascites. AJR Am J Roentgenol 156:1185–1187
8. Golper TA, Brier ME, Bunke M, Schreiber MJ, Hamilton RW, Strife F, Hamburger RJ (1996) Risk factors for peritonitis in long-term peritoneal dialysis: the Network 9 peritonitis and catheter survival studies. Academic subcommittee of the steering committee of the Network 9 peritonitis and catheter survival studies. Am J Kidney Dis 28:428–436
9. Golper TA, Burkart JM, Piraino B (1996) Peritoneal dialysis. In: Schrier RW, Gottschalk CW (eds) Diseases of the kidney, 6th edn. Lippincott/Williams & Wilkins, Boston, pp 2785–2789
10. Gough IR, Balderson GA (1993) Malignant ascites – a comparison of peritoneovenous shunting and non-operative management. Cancer 71:2377–2382
11. Greenway B, Johnson PJ, Williams R (1982) Control of malignant ascites with spironolactone. Br J Surg 69:441–442
12. Helzberg JH, Greenberger NJ (1985) Peritoneovenous shunts in malignant ascites. Dig Dis Sci 30:1104–1107
13. Kharma R, Twardowski ZJ (1996) Recommendations for treatment of exit-site pathology. Perit Dial Int 16 [Suppl 3]:S100–104
14. Lacy JH, Wieman TJ, Shively EH (1984) Management of malignant ascites. Surg Gynaecol Obstet 159:397–412
15. Lee CW, Bociek G, Faught W (1998) A survey of practice in management of malignant ascites. J Pain Symptom Manage 16:96–101

16. Parsons SL, Watson SA, Steele RJ (1996) Malignant ascites. Br J Surg 83:6–14
17. Pockros PJ, Esrason KT, Nguyen C, Duque J, Woods S (1992). Mobilization of malignant ascites with diuretics is dependent on ascitic fluid characteristics. Gastroenterology 103:1302–1306
18. Ross GJ, Kessler HB, Clair MR, Gatenby RA, Hartz WH, Ross LV (1989) Sonographically guided paracentesis for palliation of symptomatic malignant ascites. AJR Am J Roentgenol 153:1309–1311
19. Runyon BA, Hoefs JC, Morgan TR (1988) Ascitic fluid analysis in malignancy-related ascites. Hepatology 8:1104–1109
20. Salerno F, Salvatore B, Lorenzano E, Moser P, Incerti P (1991) Randomised comparative study of hemaccel vs albumin infusion after total paracentesis in cirrhotic patients with refractory ascites. Hepatology 13:707–713
21. Sardegna KM, Beck AM, Strife CF (1998) Evaluation of perioperative antibiotics at the time of dialysis catheter placement. Pediatr Nephrol 12:149–152
22. Wilcox CM, Woods BL, Mixon HT (1992) Prospective evaluation of a peritoneal dialysis catheter system for large volume paracentesis. Am J Gastroenterol 87:1443–1446