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Total Abdominal Colectomy, Pelvic Peritonectomy, and End-Ileostomy for the Surgical Palliation of Mucinous Peritoneal Carcinomatosis From Non-Gynecologic Cancer

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Background and Objectives: The optimal management of symptomatic advanced peritoneal carcinomatosis of non-gynecologic origin is not defined. Historic controls of surgical efforts report high postoperative mortality and morbidity rates with equivocal palliation. Novel surgical procedures need to be tested in terms of the impact on survival and quality of life.
Study Design: We studied 46 consecutive patients who underwent total abdominal colectomy, pelvic peritonectomy with construction of an end-ileostomy for palliation of peritoneal carcinomatosis.
Results: Total abdominal colectomy, pelvic peritonectomy, and end-ileostomy was successfully performed in 46 patients of median age of 54.4 years. Overall median survival was 10.7 months, with a mean follow-up period of 12 months. Patients with appendiceal malignancy had a median survival of 19.7 months. Prognosis was poorer for patients with colon cancer, who had a median survival of 7.0 months, while patients with primary peritoneal carcinomatosis had a median of 7.8 months. Postoperative morbidity and mortality rates were 19.5 and 8.6%, respectively.
Conclusions: Total abdominal colectomy, pelvic peritonectomy, and end-ileostomy is a technically feasible procedure and is advocated for the palliation of patients with peritoneal carcinomatosis of appendiceal origin. It is not clear if the procedure should be advocated for more invasive gastrointestinal malignancies.
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KEY WORDS: **peritoneal carcinomatosis; palliative surgery; total colectomy; pelvic peritonectomy; intraperitoneal chemotherapy; appendix cancer**

INTRODUCTION

Peritoneal carcinomatosis is no longer considered a terminal condition requiring minimal surgical intervention. Published data from the past decade suggest that aggressive surgical treatment, combined with perioperative intraperitoneal chemotherapy, is effective in the management of peritoneal dissemination in selected patients [1,2]. Unfortunately, for many patients the extent of disease or the patient's general condition only allows a palliative approach. Clear definition of the surgeon's responsibility to provide optimal palliation is currently not available.

In 10–15% of patients, primary gastrointestinal malignancy presents with peritoneal carcinomatosis. However, in autopsy studies, locally disseminated disease represents the most common pattern of surgical treatment failure, occurring in nearly 75% of patients [3]. Clinical series probably underestimate local-regional and peritoneal recurrences, whereas necropsy series provide a more complete, yet discouraging, description of the natural history of gastrointestinal cancer.

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According to the EVOCAPE 1 multicentric prospective study, the median survival of patients with peritoneal carcinomatosis of non-gynecologic origin was 3.1 months [4]. This study also reported an associated postoperative morbidity and mortality rate of 16 and 21%, respectively. In patients with peritoneal carcinomatosis, symptoms derive from complete or partial bowel obstruction, fistula formation, and debilitating ascites. The natural history of carcinomatosis includes pain, unrelenting nausea and vomiting, weight loss, starvation, a requirement for repeated hospital admissions, and a need for expensive specialized care. Endoscopic palliation of obstruction related to peritoneal carcinomatosis should always be considered but is rarely feasible, since patients suffer multiple sites of stenoses in both the large and the small bowel. Similarly, in our own review of recurrent intraabdominal cancer with intestinal obstruction, conservative surgical procedures such as colostomy, ileostomy, or gastrostomy are associated with unpredictable palliative benefits [4]. Often patients die within weeks without relief of their symptoms; as a result of surgical complications, their condition can be made worse. In contrast, the benefit of an aggressive intervention should be weighted against morbidity and mortality rates associated with the operation. The surgical literature suggests that an aggressive surgical approach would be justified if a minimum of 6 months of symptom-free survival could be achieved with an acceptable morbidity and mortality [5,6].

The present study aims to evaluate possible benefits of a new and more aggressive approach to the surgical palliation of peritoneal carcinomatosis. Total abdominal colectomy, pelvic peritonectomy, and end-ileostomy was prospectively studied in advanced peritoneal carcinomatosis from gastrointestinal malignancies. These procedures evolved as an option of palliative treatment from continued efforts to define the common sites of bowel obstruction in patients with peritoneal surface dissemination of gastrointestinal malignancy [7].

PATIENTS AND METHODS

All 46 patients who underwent total abdominal colectomy, pelvic peritonectomy, and end-ileostomy as a palliative operation for peritoneal carcinomatosis from November 1993 until June 2001 were included in the study. All patients were referred to the Washington Cancer Institute and treated at the Washington Hospital Center. The procedures were considered as palliative in that gross residual disease was left behind and no adjuvant therapy was considered to be potentially curative. The senior author was present for all operations. The likelihood of a non-curative procedure requiring ostomy construction was clearly stated to the patients and their families preoperatively. Also, the requirement for a permanent ileostomy, as well as the expected postoperative mortality and morbidity rates, were explained. All patients gave written informed consent for the surgery, intraperitoneal chemotherapy, and data analysis. Not all patients with intestinal obstruction from recurrent nongynecologic carcinomatosis during this time period were selected for this palliative surgical option. If colonic involvement was limited and sufficient disease-free large bowel could be preserved for reconstruction, intestinal continuity was reestablished; however, those patients were not included in this study. Ileorectal anastomosis was not performed in peritoneal carcinomatosis patients. If age and comorbid features suggested an excessive operative morbidity or mortality, patients were excluded. If preoperative abdominal and pelvic CT or abdominal exploration showed diffuse involvement of the small bowel suggesting no chance for return of enteral nutrition, patients were excluded [8,9]. Also, liver or systemic metastases were indications to exclude patients.

Patients' characteristics, operative reports, pathology reports, discharge summaries, and a morbidity/mortality database were reviewed and analyzed. No patient had adenomucinosis; all patients had mucinous adenocarcinoma.

Assessment of Prior Surgical Intervention

The prior surgical score (PSS) is an assessment of the extent of all prior surgical procedures [10]. To quantitate PSS, the abdomen and pelvis are divided into nine regions and the number of regions previously dissected estimated from old operative reports. PSS-0 indicates biopsy only, PSS-1 minimal prior dissection with only one abdominal region dissected; PSS-2 indicates two to five regions dissected, and PSS-3 extensive prior cytoreduction with more than five regions dissected.

Assessment of Volume of Carcinomatosis

As the abdomen was explored, the peritoneal cancer index (PCI) was recorded. PCI is a clinical integration of both peritoneal-implant size and distribution of peritoneal surface malignancy. To assess PCI, the abdomen and pelvis were divided into 13 anatomic regions. The size of the largest malignant nodule per region was scored. Zero indicated no carcinomatosis visible, one indicated tumor nodules less than 0.5 cm, two indicated nodules 0.5–5.0 cm, and three indicates tumor nodules greater than 5 cm or a confluence of disease. The summation of the lesion size score in all of the 13 regions was the PCI for the individual patient [10,11].

Surgical Procedure

All patients underwent en bloc total abdominal colectomy and pelvic peritonectomy with construction of

end-ileostomy. Additional peritonectomy procedures were performed if they provided additional debulking of cancer [12].

Cytoreduction Score

At the completion of the surgical procedure a completeness of cytoreduction score (CC) was recorded. A CC-0 score indicated that no peritoneal seeding was visible during the cytoreduction, CC-1 indicated residual tumor nodules less than 2.5 mm, CC-2 indicated residual tumor nodules 2.5 mm–2.5 cm, and a CC-3 score indicates residual tumor nodules greater than 2.5 cm [10].

Perioperative Intraperitoneal Chemotherapy

Patients received heated intraabdominal intraoperative chemotherapy (HIIC) and early postoperative intraperitoneal chemotherapy (EPIC) if all small bowel loops could be separated and tumor nodules of approximately 1 cm or less remained behind. HIIC with mitomycin-C was used for adenocarcinoma and cisplatin–doxorubicin was used for primary peritoneal surface cancer. The chemotherapy solution was perfused at 41–42°C using the ''Coliseum technique'' as standardized in a practice manual. EPIC was performed with 5-fluorouracil as a 5-day peritoneal lavage as standardized in a practice manual [13].

Follow-Up Assessment

Follow-up evaluation of all living patients was performed by phone or direct interview. Attending physicians were contacted as needed. Information on deceased patients was collected from the follow-up database, and by contacting patients' relatives and physicians. No patients were lost to follow-up.

Statistical Analysis

The endpoint of the study was survival. Statistical analysis included Student's *t*-test for comparisons of mean values. The most significant predictor for survival from univariate analysis was used to stratify the Kaplan–Meier survival curves. Survival curves were tested with a log-rank test. All statistical analyses were performed on a personal computer with the statistical package SPSS for Windows (SPSS-10.0, Chicago, IL). Statistical significance for *P*, was fixed at equal or less than 0.05 as standard.

RESULTS

Clinical Features Available Prior to Surgery

Total abdominal colectomy, pelvic peritonectomy, and end-ileostomy was performed on 46 patients (25 women and 21 men) with a mean age of 54.4 years at the time of the operation (range 31–81 years). An analysis of clinical features available prior to surgery and their impact on survival is shown in Table I. Age >70 or <70 was a prognostic clinical feature with a significant impact on survival ($P = 0.0012$). The origin of malignancy was the appendix in 22 patients, the peritoneum in 12, the colon in 9, and other sites in 3 patients. Mean and median overall survival of appendix vs. other sites was 28.1 and 10.7 months, respectively, with a median follow-up period of 12 months. Univariate analysis revealed the origin of the malignancy as a predominant prognostic factor ($P = 0.043$). Therefore, a stratified log-rank test was performed for analysis of all other variables. Patients with appendiceal malignancy had a mean survival of 41.8 months and a median of 19.7 months. Patients with colon cancer survived for a mean and median of 9.0 and 7.0 months, respectively. Primary peritoneal cancer patients showed a mean survival of 15.6 months and a median survival of 7.8 months (Fig. 1).

TABLE I. Analysis of Clinical Features Prior to Surgery and Their Impact on Survival

Clinical features	n (%)	Significance	*P*
Sex		ns	0.7318
F	25 (54.4)		
M	21 (45.6)		
Age (median: 53)		s	0.0012
>70	6 (13)		
<70	40 (87)		
Origin		s	0.0430
Appendix	22 (47.8)		
Others	24 (52.2)		
Bowel obstruction		ns	0.1070
Present	31 (37.4)		
Absent	15 (32.6)		
Abdominal pain		s	0.0468
Present	31 (67.4)		
Absent	15 (32.6)		
Ascites		ns	0.3969
Present	26 (56.6)		
Absent	20 (43.4)		
Weight loss		ns	0.1835
Present	32 (69.5)		
Absent	16 (34.7)		
Bowel perforation		s	0.0002
Present	2 (4.3)		
Absent	44 (95.7)		
PSS (median: 2)		ns	0.2303
>2	30 (65.2)		
<2	16 (34.8)		
Prior IP chemotherapy		ns	0.0764
Performed	7 (15.3)		
Not performed	39 (84.7)		
Prior systemic chemotherapy		ns	0.4452
Performed	21 (45.6)		
Not performed	25 (44.4)		
Time from diagnosis		ns	0.7840
>12 months	22 (47.8)		
<12 months	24 (42.2)		

IP, intraperitoneal.

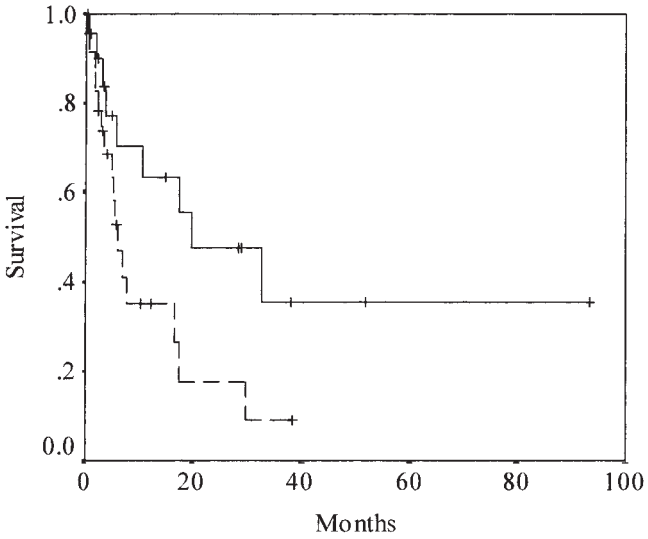

Fig. 1. Estimated cumulative percentage of patient's survival of appendiceal malignancy indicated by a solid line; all other diagnoses indicated by the dashed line.

Table I itemizes the multiple signs and symptoms recorded in these patients prior to surgery. The most common were bowel obstruction, abdominal pain, and debilitating ascites. Thirty-two patients (69.5%) reported weight loss of more than 10%. Two patients presented in the emergency department with bowel perforation and acute abdomen. A total of 47.8% of the patients presented with a combination of more than three of the above symptoms. Of these preoperative signs and symptoms, only pain and preoperative bowel perforation were associated with an impact on survival ($P = 0.0468$ and 0.0002, respectively).

Clinical Information Gained Intraoperatively

As shown in Table II, the median PCI prior to surgery was 32 (range 6–39) and the median CC score was 3 (range 1–3). Median operative time was 8 hr. Transfusion requirements reached a median of 2 (range 0–14) units of packed red cells (PRC) and 4 (range 0–16) units of fresh frozen plasma (FFP) per patient. None of these clinical features or treatments had an impact on survival. Eight patients received only HIIC and only EPIC was used in another eight. A combination of the two was performed in 20 patients. The use of HIIC alone or in combination with EPIC was associated with a survival benefit. Positive lymph nodes were present in the resected specimen in eight (17.3%) patients and distant metastases in four (8.7%) of patients. Neither had an impact on survival in these patients with carcinomatosis.

A median of 3 (range 1–4) additional peritonectomy procedures were performed per patient. The right and left diaphragms were stripped in 20 and 8 patients, respectively. The lesser omentum was resected in 35 patients. Small bowel resection was necessary in 21 patients, while partial gastrectomy was performed in 2 patients. Splenectomy was performed in 12 patients, cholecystectomy in 22, and total hysterectomy in 3. The apex of the vagina needed complementary resection in 13 patients. In 19 patients a proctectomy was performed in addition to the colectomy. Uretero–ureteral anastomosis was performed in three patients.

TABLE II. Analysis of Clinical Features and Treatment and Their Impact on Survival

Clinical features and treatment efforts	n (%)	Significance	*P*
PCI (median: 32)		ns	0.3082
>30	34 (73.9)		
<30	12 (26.1)		
CC (median: 3)		ns	0.6274
>2	39 (84.7)		
<2	7 (15.3)		
PRC transfusion (median: 2)		ns	0.9608
>2	25 (54.3)		
<2	21 (53.7)		
FFP transfusion		ns	0.2337
>4	13 (28.2)		
<4	33 (71.8)		
HIIC		s	0.0171
Performed	8 (17.3)		
Not performed	36 (82.7)		
EPIC		ns	0.0918
Performed	8 (17.3)		
Not performed	36 (82.7)		
HIIC + EPIC		s	0.0202
Performed	20 (43.4)		
Not performed	26 (42.6)		
Positive lymph nodes		ns	0.2595
Present	8 (17.3)		
Absent	38 (82.7)		
Distal metastases		ns	0.3543
Present	4 (8.7)		
Absent	42 (91.3)		

PCI, peritoneal cancer index; CC, completeness of cytoreduction; PRC, packed red blood cells; FFP, fresh frozen plasma; HIIC, heated intraoperative intraperitoneal chemotherapy; EPIC, early postoperative intraperitoneal chemotherapy.

Median hospital stay was 23 days, ranging from 10 to 57 days. Grade I and II (minor complications) morbidity occurred in 54% of patients. Grade III and IV (major complications) occurred postoperatively in 19.5% patients, while postoperative mortality rate was 8.6% (four patients) (Table III). In total, 40 out of 46 patients (86.9%) were discharged home, while 2 needed acute or subacute facilities for less than 30 days. Home TPN was required for 13 patients on their discharge. Gradual weaning from TPN was possible for eight of these patients. During the follow-up period, 21 (45.6%) patients required a mean of 1.4 re-hospitalizations, at an average of 8.9 months postoperatively. In total, 7 (15.2%) patients

TABLE III. Postoperative Morbidity and Mortality in Patients Who Underwent Total Abdominal Colectomy With Pelvic Peritonectomy for Advanced Peritoneal Carcinomatosis

Grade I/II	n	Grade III/IV	n	Postoperative deaths	n
UTI	11	ARDS/MOF	2	ARDS/MOF	2
Line sepsis	5	Bleeding	2	Stroke/MI	1
Wound infection	3	Stroke/MI	1	Bleeding/PE	1
Atelectasis	2	Bile fistula	1		
DVT/PE	2	Pneumothorax	1		
Subclavian VT	1	Urethral fistula	1		
Pancreatitis	1	Urinoma	1		
Total n: 25 (54.3%)		Total n: 9 (19.5%)		Total n: 4 (8.6%)	

Grade I morbidity indicated an asymptomatic complication; grade II morbidity indicates complications that required minimal intervention. Grade III morbidity indicates complications that required invasive intervention; grade IV morbidity indicates complications that required major intervention or return to the operating room. DVT, deep vein thrombosis; ARDS, acute respiratory distress syndrome; MOF, multiple organ failure; UTI, urinary tract infection; PE, pulmonary embolism; MI, myocardial infarction.

were re-operated for bowel obstruction at a mean of 14 months following the colectomy. A benign obstruction was the reason for three early re-operations (<3 months postoperatively), while a late malignant obstruction occurred in the remaining four patients.

DISCUSSION

Unfortunately, a considerable number of patients present with advanced peritoneal carcinomatosis of gastrointestinal origin with no prospect of curative treatment. Nevertheless, signs and symptoms of pain, bowel obstruction, fistula formation, and malignant ascites require palliation and a surgical responsibility to optimally manage these patients exists. After considering the patient's age, comorbid features, primary cancer site, and extent of disease, the surgeon may proceed with a limited surgical intervention that provides an unpredictable palliative benefit. The data in this article suggest that a more aggressive palliative approach accompanied by an acceptable morbidity and mortality is a new treatment option to be considered.

The most usable evidence-based data regarding this problematic group of patients would require a phase III study of conservative versus aggressive surgical management. In such a clinical research effort, prospective data comparing pain, recurrence of intestinal obstruction, total number of days in the hospital, and quality of life could be made available. Unfortunately, difficulties in the design, implementation, and completion of such a study with multiple endpoints would be difficult, probably impossible. For example, it is doubtful that a quality of life assessment appropriate for this group of patients has been validated. In this article, data is provided regarding a new option for patients; also some selection factors that suggest benefit are provided. The surgeon's judgement is required to make a choice between the multiple treatment options, none of which are likely to produce great benefit.

The pathophysiologic rationale for total abdominal colectomy, pelvic peritonectomy, and end-ileostomy derives from the patterns of intra-abdominal dissemination of gastrointestinal cancer [7]. The large bowel is involved by cancer to a greater extent than the small bowel or stomach. The rectosigmoid colon lies deep in the cul-de-sac usually surrounded by high volume disease and may become obstructed at the pelvic outlet. The transverse colon in most patients is entrapped by the omental cake and must be resected en bloc with the omentum. Clinical studies document that the most common sites of obstruction in carcinomatosis are the least mobile portions of the large bowel, especially the ileocaecal valve. If there is a large volume of carcinomatosis at the pelvic outlet, within greater omentum and at the ileocaecal valve with relative sparing of the small bowel, the patient should be considered a candidate for total abdominal colectomy, pelvic peritonectomy with end-ileostomy.

A majority of patients with peritoneal carcinomatosis will eventually develop bowel obstruction; these patients who present with intestinal obstruction as a consequence of progressive intra-abdominal malignancy have a poor prognosis. A median survival of 1–6 months is reported following less aggressive palliative surgery [11–13]. Some authors advocate non-operative management, but all such efforts are followed by a high rate (40–80%) of early re-obstruction [14]. When surgical interventions are required with obstructed bowel, an anastomosis may not be feasible. Also, performance of an anastomosis through cancerous tissue is to be avoided. The small bowel, although it may carry a large number of small cancer nodules, is relatively free of a large volume or confluent disease. Also, the low viscosity of small bowel's contents will prevent mechanical obstruction for a prolonged period of time. Near complete clearing of the abdomen and pelvis of cancer without the postoperative dangers of an intestinal anastomosis are the major virtues of this new operation for carcinomatosis.

Most of these patients underwent additional peritonectomy procedures that provided additional debulking. Additional procedures included lesser omentectomy, stripping of right and left diaphragm, small bowel resection, partial gastrectomy, total abdominal hysterectomy with bilateral salpingo-oophorectomy, cholecystectomy, proctectomy, and splenectomy. Small bowel resection was performed when it was obstructed or likely to obstruct in the near future; resections were most commonly in continuity with the terminal ileum. Partial gastrectomy was

necessary in two patients because tumor was causing gastric outlet obstruction and debulking of the antrum of the stomach with the use of electrosurgery was not possible. With mucinous tumors, subdiaphragmatic spaces were consistently involved; stripping reduced the intra-abdominal cancer burden, reduced future respiratory insufficiency, and prevented early disease progression in the pleural spaces. Splenectomy was usually performed along with the greater omentectomy as the omental cake surrounded this organ. Lesser omentectomy was performed to treat or to prevent gastric outlet obstruction. Proctectomy was used in cases of prior low anastomosis, with deep invasion of the tumor in the pelvis so that a rectal stump available for closure was absent, or with pelvic infection. In some patients a proctectomy may reduce the likelihood of complications by eliminating the possibility of leakage from the closure of the rectal stump.

The pelvic peritonectomy is an essential component of this approach in that it clears a large volume of cancer from the pelvis and prevents early obstruction of the ureters. It proceeds in a retroperitoneal plane that eliminates cancer from the bladder, pelvic sidewalls, and culde-sac. Occasionally invasion of the ureter may require a transuretero-ureterostomy; this was used in 3 out of 46 (7%) of our patients. Bilateral obstruction may be considered a contraindication to the operation.

Over half of our 46 patients presented with debilitating ascites causing major discomfort and requiring multiple prior paracenteses. Malignant ascites is considered a sign of end-stage disease with a median survival for symptomatic patients of approximately 2 months [15]. Major surgery in patients with malignant ascites is associated with a mortality rate of up to 41% [16]. Peritoneovenous shunts, repeated abdominal paracenteses, or permanent peritoneal drainage catheters do not offer substantial palliation and are also accompanied by a high complication rate [17,18]. In our experience and in that of McQuellon, this approach to bulky cancer was adequate palliation of debilitating ascites [19].

The use of HIIC and EPIC probably had a positive impact on survival especially of appendiceal cancer patients who are unlikely to develop systemic disease. This targeted chemotherapy may also contribute to a better quality of life [19]. However, the lack of controlled data precluded any conclusions regarding the use of intraperitoneal chemotherapy for these patients.

The perioperative mortality and morbidity in these 46 patients requiring palliative surgery for advanced peritoneal carcinomatosis were high but not unacceptable. The approximate 20% morbidity and 9% mortality occurred with salvage and emergency procedures on patients with a poor performance status. A majority of deaths occurred early in the course of the study; alterations in selection criteria and medical management resulted in reduced mortality over the last 20 cases. Probably such aggressive palliation should not occur in patients over 70 years of age. A less than 5% postoperative mortality rate is considered feasible for the future.

When to and when not to proceed with an aggressive surgical palliation for recurrent gastrointestinal cancer remains a dilemma. Total abdominal colectomy and pelvic peritonectomy with end-ileostomy is an option for palliation in patients with advanced peritoneal carcinomatosis. Selection of this strategy from the many others available is governed by the pattern of cancer spread and by the patient's operative risks. Continued efforts to establish selection criteria that would increase long-term benefits, reduce postoperative morbidity and mortality, and enhance quality and length of life of carcinomatosis patients are needed. These data show that patients with mucinous appendiceal cancer should be considered to have a palliative surgical option. The unexpectedly long median survival of 19.7 months justifies this approach. Patients with colon carcinomatosis or of other origin carcinomas are poorer candidates for this operation. The low incidence (4 of 46) of recurrent intestinal obstruction from cancer prior to death after this extensive clearing of the abdomen of gross disease may be a strong endorsement of this approach in selected patients. The small number of relatively long-term survivors suggests that better inclusion criteria could be used in the future.

Some contraindications to an aggressive palliative surgical intervention were suggested by this study. Age greater than 70 years should be considered a relative contraindication. Also, abdominal pain and bowel perforation suggest a poor outcome. In addition, evidence of multiple distant metastases would disqualify the patient for this procedure. A large volume disease on the small bowel or its mesentery so that intestinal function is unlikely to resume postoperative is a contraindication.

Finally, this aggressive palliative intervention may not be applicable at all institutions. It requires a young (age 40–70), highly motivated, and well-informed patient who desires a maximum effort to achieve the longest survival possible. The need for specialized home-care was crucial and should be carefully considered. Long-term home intravenous feeding was required for 11% of patients and is readily available in the USA. Expense versus benefit studies have not been performed to compare the cost of a life year using this approach to the other possible treatments. Of course, prevention of carcinomatosis would always be preferred to palliative treatments.

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