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Abstract

Purpose

It is uncertain if home parenteral support (HPS) is of advantage in patients with incurable cancer and intestinal failure, functional obstruction or severe malabsorption. From a single centre cohort we present characteristics of patients with incurable cancer treated with HPS.

Methods

Over a ten year period (2005-2015) data were retrospectively collected on patients with incurable cancer discharged on HPS from a Danish tertiary referral centre. Data on socio-demographics, catheters and parenteral nutrition, catheter related complications, re-admissions and mortality were analysed. The inflammation based score; modified Glasgow prognostic score (mGPS) was investigated as a prognostic score by Cox proportional hazard regression analyses adjusted for sex, age, diagnosis, and pathophysiological conditions.

Results

Eighty patients with incurable cancer, aged 25.1-83.6 (median 63.8) were identified. Patients with gynaecologic cancer accounted for 25% of the cohort, thus women predominated. Short bowel syndrome was more prevalent in the patients with gynaecologic or lower gastrointestinal cancer compared to the upper gastrointestinal cancer. Catheter related complications occurred in a minority of patients (31%); most frequent was catheter related bloodstream infection (CRBSI). CRBSI rate was overall 0.97 pr 1000 catheter days, depending on diagnosis. Eleven percent had several infections, and 75% did not have any. Patients self-administering the catheter were younger, less frail and had fewer CRBSI events. Re-admissions were prevalent, and only one fifth of the patients had no re-admissions after initiation of HPS. Patients with mGPS 0 or 1 survived significantly longer, median 372 (CI 39-2006) days versus patients scoring 2 in mGPS, median 43 (CI 6-578) ($p<0.01$). In patients with mGPS 0 or 1 survival at six months was 75% and in patients with mGPS 2, 20%. In multivariate cox regression analyses mGPS 2 was a significant predictor of mortality (HR 4.66, 95% CI 2.65-8.20, $p<0.01$).

Conclusions

It is feasible to offer HPS to patients with incurable cancer. Frequency of catheter related infections is acceptable but most patients will be re-readmitted after initiation of HPS. Predictors of survival in patients with incurable cancer on HPS may include mGPS. However, our study does not give a clear answer; when to prescribe HPS and who might possible benefit from the treatment in patients with incurable cancer.

Keywords: cancer, home parenteral support, parenteral nutrition, catheter related bloodstream infections, CRBSI, mGPS, overall survival

Introduction

Little is known about the benefits of home parenteral support (HPS) in patients with incurable cancer. Weight loss is dominant in this patient group but the nutritional demands are only sporadically recognized and handled [1]. In some patients the nutritional needs are unmet by prescription of oral or enteral nutrition for a variety of reasons. In this setting home parenteral support (HPS) may be the only possible way to meet the patient's nutritional needs. Proposed advantages of HPS in patients with incurable cancer are improvement in quality of life [2, 3] and prolongation of life [4]. The encounters to HPS in patients with incurable cancer are the need to endure infusions, often during night time, and the constant risk of inevitable catheter related complications. As well HPS is considered expensive and it has practical implications for the patients and their families [5, 6].

When deciding to offer HPS to patients with incurable cancer there is a need to consider the risk of complications and re- admissions due to catheter related complications [7].

Previous studies on the effect of HPS in incurable cancer patients are not consistent, and the treatment is prescribed to patients with different cancer diagnoses [8-12]. Several studies have reported outcome on patients with incurable cancer and bowel obstruction [4, 13, 14] but there is sparely evidence on HPS if other pathophysiologic conditions have caused initiation of HPS. In terms of time consumption, complications, and survival it is not finally settled whether HPS is advantageous in patients with incurable cancer and chronic intestinal failure, functional obstruction or severe malabsorption. Likewise, little is known about how to select incurable cancer patients for HPS.

For twelve years patients have been discharged with HPS from the department of Medical Gastroenterology at Odense University Hospital, one of four intestinal failure units in Denmark. The treatment has been offered not only to patients

with Short Bowel Syndrome (SBS) but also to patients with incurable cancer and chronic intestinal failure, functional obstruction or severe malabsorption.

Outcome of the treatment has not previously been documented in this patient group and the modified Glasgow prognostic score (mGPS) may possibly be valuable in this selected group of patients with incurable cancer. mGPS, based on CRP and albumin, has demonstrated power as a prognostic tool in patients with incurable cancer [15-18] independently of stage and treatment. Also an association between mGPS and quality of life has been demonstrated by Laird et al [19], independent of performance status.

In this study we will describe socio demographics and clinical characteristics of a cohort of patients with incurable cancer discharged on HPS, and compare the differences between cancer types focusing on pathophysiology, complications and survival. Furthermore, we will forward a preliminary evaluation of mGPS as predictor of overall survival.

Methods

Patient and data collection

Patients (n=291) discharged on HPS from the department of Gastroenterology at Odense University Hospital were identified from the administrative database for the period January 2005 to December 2015. Patients eligible for this study were: patients with incurable cancer and age > 18 years. Exclusion criteria were patients receiving HPS in an ongoing randomized clinical trial. Receiving HPS required a central venous access; type of central venous access and HPS administration was individualized according to patient wish. As well, prescription of HPS did require, insufficiency of enteral nutrition, an estimated survival of a minimum of three months and an expected improvement of performance status and quality of life[20]. All patients discharged on HPS from the department were trained and educated by dedicated nurses using a standard care protocol [21] and as well patients were sent home with the availability to use the learning application "Mit forløb" (which may be translated to "my course of illness"); https://mit.rsyd.dk/home developed in the department.

Data on socio demographics, tumour characteristics, bowel length, pathophysiology, HPS, catheter related complications, length of stay, readmissions, mGPS, and survival were retracted. Data were extracted from medical records and entered to the database by a physician and two specially trained nurses.

Definitions

Socio demographic data , including age, sex, education, marietal -and employment status, and BMI ,were assessed at time of initiation of parenteral support (PS) administered through a central venous access. Marital status was defined as cohabitants' vs patients living alone (including patients living in nursing homes). Employment status was categorized at five levels: student, permanent, flexible, no employment or unknown

Tumour type was classified using ICD-10 classification and stratified in four groups according to anatomic origin of the tumour.

Length of the remnant functional bowel was accessed during surgery or by postoperative evaluation, although the length of the bowel is an arbitrary measure, depending on the method used (surgical, radiologic or autopsy) [22-24]. Length of the remnant intestine was given in centimetres from the ligament of Treitz, under the assumption of the normal length of jejunum being 200 cm and ileum 150 cm. Percentages were used to describe colon length in accordance with the terms used by Cummings et al [25]. The term pathophysiologic classification was first used by Scott et al [26] and refers to short bowel syndrome (SBS), intestinal fistulae, mechanical obstruction, intestinal dysmotility, extensive mucosal disease, and a combination of two or more of these conditions. All the above mentioned categories were defined in accordance with the Copenhagen IF (Intestinal Failure) database [27].

HPS-time was defined as the date from first discharge with HPS. Basal metabolic rate (BMR) was calculated using Harris-Benedict equation using sex, age, height and weight [28]. Nutritional requirements was estimated to be; energy 125 kJ/kg/day, protein 1.2g/kg/day, fluid 35ml/kg/day. The catheters registered were: non tunnelled central venous catheters (CVC), tunnelled central venous catheters (tCVC), totally implantable venous access device (Port à Cath) or peripherally inserted central catheter (PICC).

Complications registered were CRBSI's (a clinically documented systemic infection, bacteraemia originating from a central venous catheter, central or /and peripheral and exclusion of other source of infection [29]), tunnel infections (clinical verified erythema, tenderness, induration of the skin and tissue extending more than two cm's from the catheter exit site), mechanic complications (occlusion, displacement or damage to the central venous access) and venous thrombosis in relation to the central venous access (radiologically visualised). All the above mentioned terms were in accordance with the definitions introduced by Brandt et al [30].

The length of stay at commencement of HPS and the number and reasons for re-admissions were registered.

The mGPS consists of the two parameters; CRP and Albumin and it is calculated as follows: C-reactive protein (CRP) <10 mg/L =0; CRP>10 mg/L =1, CRP >10 mg/L and albumin<35 g/L =2[31, 32].

142 Survival was defined as the time interval from start of HPS to date of death, not including the period on parenteral
143 support in hospital before discharge on HPS.
144
145 *Statistical analyses*
146 Data were entered into a database in the web-based program RedCap (Research Electronic Data Capture) in a secure
147 web application managed by OPEN, Odense Patient data Explorative Network, Odense University Hospital, Denmark.
148 All analyses were carried out using Stata (Version14. Statistical software, College station, Texas: StataCorp LLC).
149 The patients were stratified into four groups: upper gastrointestinal cancer, lower gastrointestinal cancer, gynaecological
150 cancer, and other cancer. 'Other cancer' included eight patients with diverse diagnoses: GIST, lung, breast, urological,
151 and one unknown. Relative frequencies (N, percentages) were used for categorical variables (sex, tumour site/ spread,
152 marital state, education, pathophysiology, type and number of catheters, number of complications, catheter handling,
153 and mGPS [33]). Median and range were presented for the continuous variables (age, BMI, bowel length, treatment
154 time, catheter days, parenteral nutrition and fluids).
155 Comparisons between the four cancer groups were made using the one-way Anova with Bonferroni correction when
156 appropriate and for the data not satisfying the criteria of equal variance the Kruskal Wallis test was utilised. Differences
157 in frequencies (categorical data) were analysed using Fisher's exact test. Admissions, complication rates and types were
158 presented using frequency tables, comparisons between prevalence in the cancer groups were tested using Fisher's exact
159 test.
160 The overall survival according to mGPS score was defined as the number of day's surviving after initiation of HPS.
161 Time to death was presented by Kaplan-Meier curve. The Cox proportional hazard regression was applied to identify
162 variables associated with survival. The Cox regression model was adjusted for mGPS, sex, age, diagnosis and
163 pathophysiology. Predictor variables were included in the model if $P<0.10$ in the univariate analyses. Significance level
164 of $p< 0.05$ was mandatory for variables to stay in the model. To control for appropriateness of the model the
165 proportional hazard assumption was acquired and tested using Cox-Snell Residuals. Harrell's C concordance statistic
166 was used to validate the final model.
167
168 **Results**
169 *Socio demographics and clinical characteristics*

From the cohort of 291 HPS patients 80 (27%) patients had an incurable cancer at initiation of HPS. Two thirds of this cohort were women, median age 64 (CI 25-84) years, and classified with a normal BMI. Half of the cohort had upper gastrointestinal (GI) cancer; one third had gynaecologic, one fifth had lower GI and less than one out of ten had 'other' cancer. (*Table 1)*

At time of initiation of HPS the majority of patients 71 (89%) had metastases and peritoneal carcinomatosis was verified in 46 patients (58%). Length of remnant bowel differed between the diagnoses. Thus, bowel resection before starting home parenteral support was done in 57 (71%) patients but SBS (small intestine<200cm) [34] was only present in 25 (31.3%) patients. Radiation enteropathy was not common and only found in four (7%) of the 57 resected patients. Majority of the patients with gynaecologic cancer (80%) had peritoneal carcinomatosis at baseline and in this cancer group bowel resection was prevalent before starting HPS. The pathophysiology differed between the cancer groups, with a high prevalence of SBS in the patients with gynaecologic cancer 13 (59%) in contrast to the patients with upper GI cancer where only 3 (7.5%) were classified with SBS. The patients with upper GI cancer had significant longer remnant bowel than the other cancer groups and mGPS 2 was more prevalent than in the patients with gynaecological cancer.

Parenteral nutrition and catheters

Median daily infusion volume was 1787.6 ml (range 598.1 to 4000 ml pr. day). At first discharge seven patients received only intravenous fluids. Lipids were provided in 65 (81%) patients to ensure calorie intake while restricting the fluid volume. The amount of nutrients did not differ significantly between the groups and was not solely dependent on the pathophysiologic condition. All patients were encouraged to eat normal foods only restricted by eating difficulties, nausea or excessive stoma output. Thirty-four (43%) patients received the essential amount of calories from parenteral nutrition estimated by BMR. In this group parenteral calories received was 115.4 kJ/ kg/ day (range 81.9-194.9) and proteins was 1.07 g/ kg/ day (range 0.5-1.9).

Most patients were discharged with a tCVC (81%); though three were discharged with a CVC to hospice. As presented in (*table 2)*, 80 patients in total had 140 catheters (97 (69 %) were tCVC) covering 29.191 days of HPS. More than half (56%) of the patients had only one catheter insertion and 15 (19%) had more than two catheters during time on HPS. A home care nurse handled the HPS and catheters in 63% of the patients. Patients self-administering the catheter were significantly younger and had lower mGPS than patients who were cared for by the home care nurse or the relatives.

HPS time did not differ significantly with patient age or sex. Most of the patients 65 (81%) received HPS continuously until time of death. At the time of data collection six (7.5%) patients were still alive after a median of 1339 HPS days. Nine patients terminated HPS for reasons other than death, and did so due to; intestinal adaption (5%), perception of uselessness or non-effectiveness (4%), surgery (1%) and emigration (1%).

Catheter related complications

Complications were restricted to a minority of patients 25 (31%) carrying all 58 complications; hence 55 (69%) of the patients had no complications. Complications were more frequent in patients with a gynaecologic cancer (*table 3)2.03 pr 1000 catheter day*. Most frequent complication was CRBSI's, accounting for 47 events and detected in 20 patients. Half of the patients had one infection and another half had more than one infection. CRBSI rate was overall 0.97 pr 1000 catheter days, the rate in patients with upper GI cancer were 1.3 CRBSI's pr. 1000 catheter years and 0.36 in patients with lower GI cancer. Patients handling their own catheter had eight (17%) and catheters handled by a relative accounted for five (11%) CRBSI's. Patients who had the home care nurses handling the catheter accounted for 34 (72%) of the CRBSI's. The identified number of thrombotic events or tunnel infections were low, with only one catheter related thrombosis and one tunnel infection detected during the observation time. CRBSI related death was observed in four (5.5%) patients all having a home care nurse administering the HPS.

Length of stay and re-admissions

Median length of stay at HPS commencement was 16 days, with a maximum of 66 days. Patients discharged with HPS for self-administration had shorter admittance, in median 10 (3-42) days versus 16 (11-49) days and 17 (3-66) days for the ones who were cared for by the relative or the home care nurse (p=0.15). The majority, 65 (81%) were re-admitted at least one time and in total 65 patients had 278 re-admissions. Reason for re-admission was in 38% triggered by CRBSI or other infections (not catheter related), and less than ten percent of the re-admissions were caused by nutrient or fluid irregularities. Re-admission time for CRBSI was in median 11 (4-23) days, and the number of re-admissions did not differ significantly between the groups as reported in (*table 3)*.

mGPS and Survival

Survival was analysed for the patients according to mGPS score. Patients with mGPS equal to 0 or 1 had a significant better survival, median 372 (CI 39-2006) days than patients scoring 2 in mGPS median survival 43 (CI 6-578) ($p<0.01$). Survival at 6 and 12 months in patients with mGPS 0/1 was (75%) and (52.3%), respectively. After 6 and 12 months survival in patients with mGPS 2 was (20%) and (8.6%), respectively. The patients surviving less than one month on HPS all had a mGPS equal to 2 which was significantly different from the patients surviving more than two years, who all had mGPS less than 2. There was a significant difference in median HPS time for the patients with mGPS 0 or 1 compared to the patients with mGPS 2. The survival is presented for mGPS 0 and 1 compared to mGPS 2 in (*figure 1)*. In the univariate Cox regression analyses cancer type, age, mGPS and a combination of pathophysiologic conditions were independently associated with survival. In the multivariate Cox regression analyses mGPS was the only significant predictor. Result of the Cox regression analyses is presented in (*table 4)*.

Discussion

In the present study we provide retrospective data on a cohort of patients with incurable cancer receiving HPS. Patients treated in our cohort were heterogeneous with regard to diagnosis and pathophysiology. Catheter related complications were found in a minority of patients, and most patients did not have any during the treatment time. Re-admissions were frequent and only one fifth had no re-admissions after discharge on HPS. The overall survival was significantly longer for the patients with mGPS 0 and 1 compared to patients with mGPS 2.

Uncertainty exists on the indication for prescribing HPS in patients with incurable cancer. In Denmark the approach is generally very conservative and patients receiving oncological therapy in a palliative setting will often experience marked weight loss without intention to prevent or treat malnutrition from health professionals. It is clear that previously published studies are not consistent and it is possible that the results reflect heterogeneity of cohorts and difference in outcome measures. A German multicentre study reported that the most frequent indication for prescribing HPS was ‘others’ [35] excluding ‘impairment of gastrointestinal passage’ and ‘malabsorption’, leaving the indication for parenteral nutrition unclear. Not knowing the specific prescription patterns leave it unclear when to expect benefits of the treatment. It appears that prescription of HPS may be controlled by emotions more than by evidence. The study by Chouhan et al [13] describes a notable low efficacy of treatment with parenteral nutrition. In their cohort all patients had malignant small bowel obstruction, performance status was not stated and one third of the patients received third line chemotherapy and needed hospitalization while starting chemotherapy. These factors could explain the poor outcome for the functional short bowel patients, with high prevalence of hospitalization.

Our study is hardly generalizable to all patients with incurable cancer, due to selection bias; the patients included in this study were all patients admitted to a highly specialized department treating HPS patients. Due to the retrospective nature of the study, the limited number of patients and the heterogeneous population statistics were limited. The patients included were all considered to require parenteral support to maintain a nutritional state compatible with life. However, we cannot from our study determine the individual indication for initiating HPS or the efficacy of the treatment.

CRBSI was the most frequent complication and one quarter of the patients suffered all the CRBSI's. Patients with gynaecologic and lower GI cancer, including more SBS patients, had numerous CRBSI's. But the rate of CRBSI's pr. 1000 catheter years was highest in patients with Upper GI cancer. Most infections were detected in patients having the home care nurses handling the catheter, which is in line to the findings in a previous study [36]. Reasons for patients not handling the catheter is noncompliance due to the rather demanding procedures or/and lack of functional capability. These patients are basically more frail to complications and will have the catheter handled by the home care nurses. The higher rate of CRBSI's in patients not caring for the catheter themselves may be a result of inadequate handling of the catheter or lack of training of the home care nurses. As previously reported multiple handlers of the catheter may be associated with a higher risk of complications [37] Furthermore, we found that CRBSI related death was observed in a rather high number (5%) and exclusively in patients having a home care nurse handling the catheter, which emphasizes the need for highly specialized education of the home care nurses.

The reported incidence of CRBSI's differ; Cotogni et al [38] reported a CRBSI incidence of 0.35/1000 catheter days, but the infectious events were only counted in a single central venous catheter for each patient. In a recently published study by Vashi et al [39] a total of 16 CRBSI's were recorded in 335 patients with cancer and the overall incidence of CRBSI's were 0.54/1000 HPN days.. We found a higher incidence of CRBSI's (0.97/1000 HPS days), but also a median HPS time of 364.9 days in contrast to HPS time of 43.5 days, which could be part of the explanation of the difference found in complication rate. It is important to stress that the risk of CRBSI's was not increased in this cancer cohort, compared to the numbers reported in non-malignant HPS patients [40]. Thrombotic events could be expected since malignant disease induces hyper-coagulopathy and with an even higher risk in patients with ovarian, stomach, and pancreatic cancer [41]. Remarkably, we detected only one catheter related thrombotic event in this cancer cohort, bearing in mind that twelve percent of the cohort actually received anticoagulants due to previous thrombotic events not related to the catheter. In other studies the thrombotic events has been reported to be slightly higher in HPS receiving patients with cancer [40].

Length of stay at HPS commencement was shorter for patients discharged to self-administration, which might not be remarkable as these patients were younger, and had better performance status. After discharge on HPS re-admissions were frequent. Two thirds of the patients were re-admitted to the hospital at least once after initiating HPS, but only a minority of the re-admissions were due to nutritional or fluid irregularities. Considering quality of life, length of stay caused by CRBSI's may be of great importance for the patients, and among the cancer groups we found no difference in re-admission time.

Previous studies have highlighted the possible prognostic advantage of mGPS in patients with incurable cancer [42]. In our study patients with mGPS 2 had a significant shorter survival, independent of the cancer diagnosis. Two thirds of the patients died within one year and there was a strong correlation between survival and mGPS. Our preliminary evaluation of mGPS confirms the previous findings, and may be a useful support in the difficult decision offering HPS to patients with incurable cancer.

We found a survival of median 203 days (6.8 months). This is slightly longer than the survival rates reported by Hoda et al [12] who included a heterogeneous group of incurable cancer patients with different pathophysiologic conditions. Other studies have reported shorter median survival in patients with obstruction; in the study by Chermesh et al [43] survival was in median 140 days~4.7 months, Bozzetti et al [44] and Brard et al [45] reported a survival of a median 3.0 months and 72 days ~ 2.3 months respectively and Santarpia et al [46] stated an even shorter survival of median 45 days ~1.5 months. Patient selection in the mentioned studies was restricted to incurable cancer patients with obstruction in the gastrointestinal tract. Reason for the longer survival found in our study, especially for patients with upper GI cancer, may be a consequence of a more strict selection of patients to HPS. All patients in our study had intestinal failure according to the definition by Pironi et al [47] caused by SBS, obstruction, dysmotility or a combination of the last mentioned. Enteral feeding will always be first choice of treatment, and parenteral support was only offered if the patients were not able to tolerate oral or enteral feeding. Reasons for the difference found in overall survival is likely to be the inconsistency in pathophysiology and life expectancy at baseline, in our cohort only one fifth were classified with bowel obstruction and life expectancy was estimated to be at least three months at initiation of HPS. We believe that the careful selection of patients to HPS may augment the time of survival and minimize the risk of complications.

The discrepancy in the mentioned studies highlights the need for solid evidence in providing HPS to patients with incurable cancer. To further evaluate the benefit of HPS in this patient group it will be necessary to agree upon outcome assessments before eventually setting up an intervention study. Outcome measures of importance could be QoL, overall survival, muscle mass and function.

Conclusion

This study gives a characteristic of a cohort of patients with incurable cancer and highlights the necessity of common definitions to identify patients expected to benefit from HPS. Re-admissions were common and we found a higher risk of complications but also longer treatment time than in previously reported studies. Restricted selection of patients with incurable cancer to HPS, requiring an estimated survival of 3 months, resulted in a longer median overall survival.

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Ethics

Ethics permission was unnecessary due to the retrospective nature of the study. Permission to use the data without obtaining informed consent from the patients was obtained 17. December 2015 from the Danish Patient Safety Authority (3-3013-1381/1/). Permission for handling and storage of the data was obtained from the Danish Data Protection Act (14/21137).

Data availability

Data is available from OPEN, Odense Patient data Explorative Network, Odense University Hospital, Odense, Denmark. We are under signed contractual obligation to share the data through OPEN. Interested researchers can email to open@rsyd.dk for further information about data access.

Statement of authorship

All authors contributed to design of the study. SRO collected the data and analysed and interpreted the data in close collaboration with BW and JK. SRO, BW and JK drafted and critically revised the manuscript. All authors read and approved the final draft of the manuscript and were responsible for all efforts completing the draft.

Conflict of Interest

The authors declared no conflict of interest with respect to the manuscript

Statement and Funding sources

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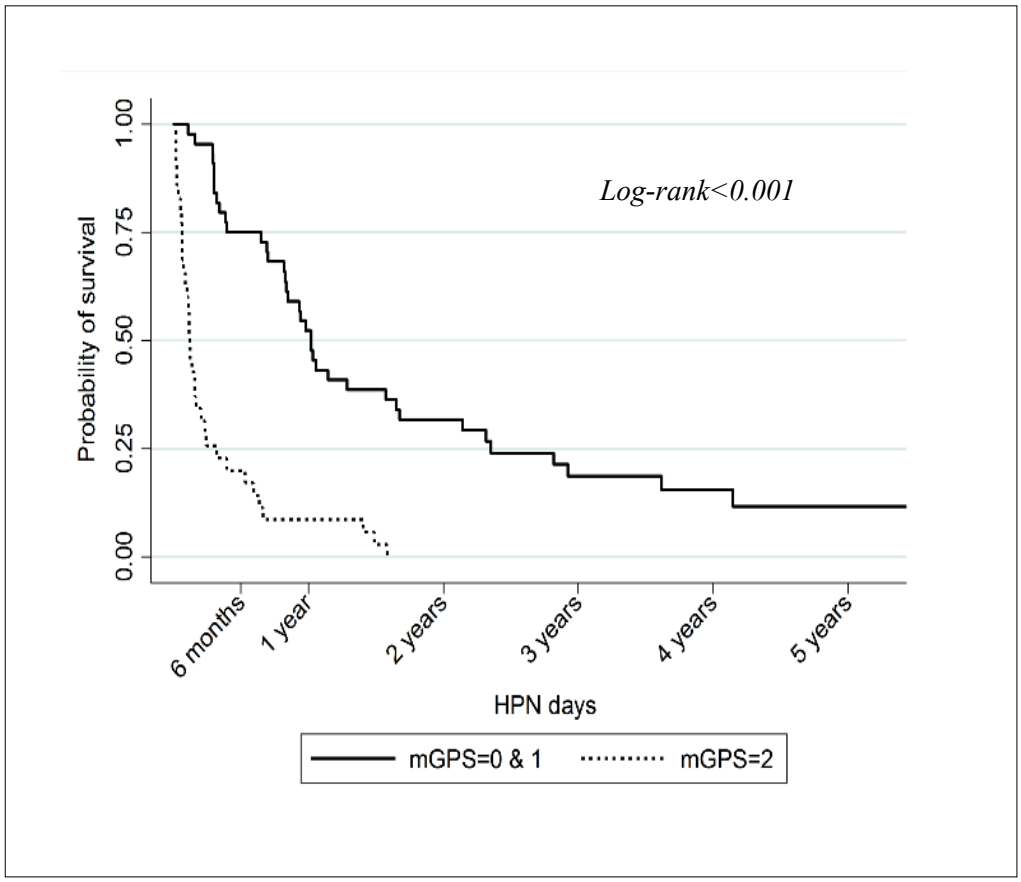

Fig 1 Kaplan-Meier survival estimates according to mGPS.

	ALL	Upper GI[a] Cancer	Lower GI[b] Cancer	Gynaecological[c] Cancer	Other[d] cancer
N (%)	80	40 (50)	10 (12)	22 (28)	8 (10)
Sex	53 (66)	22 (55)	5 (50)	22 (100)	4 (50)
N= women (%)					
Age at start of HPS, years	63.8	63.2	64.7	63.7	67.3
	(25.1-83.6)	(43.6-83.6)	(49.5-76.1)	(25.1-77.9)	(52.1-77-9)
Education					
N=no tertiary education (%)	41 (51)	25 (63)	5 (50)	9 (41)	2 (25)
Marital Status					
N=cohabitants (%)	62 (77)	31 (78)	6 (60)	21 (95)	4 (50)
BMI (kg/m$^{2)}$	20.7	20.3	20.2	21.3	21.2
at first admission	(14.1- 38.5)	(14.6-32.9)	(16.4-24.4)	(18.6-38.5)	(14.2-28.3)
BMI					
<15	2 (3)	1 (2)	-	-	1 (12.5)
15-18.4 Underweight	15 (19)	11(28)	3 (30)	-	1 (12.5)
18.5-24.9 Normal	54 (67)	23 (57)	7 (70)	19 (86)	5 (62.5)
25.0-30 Obese	9 (11)	5 (13)	-	3 (14)	1 (12.5)
Peritoneal Carcinomatosis	46 (58)	21 (53)	3 (30)	18 (82)	4 (50)
Bowel resection	57 (71.3)	23 (57)	9 (90)	20 (91)	5 (62)
Remnant jejunum length(cm)	150.0(50 - 200)	150 (110-200)	130 (50-200)	150 (50-200)	200 (165-200)
Remnant ilium length (cm)	80 (0 – 150)	150 (0-150)	0 (0-150)	0 (0-140)	40 (0-127)
Remnant colon length (%)	0 (0 - 100)	86 (0-100)	0 (0-37)	0 (0-80)	0 (0-100)
Stoma	40 (50)	8 (20)	9 (90)	20 (91)	3 (37)
Pathophysiology (*Scott et al 1991*)					
SBS	25 (31)	3 (8)	5 (50)	13 (59)	4 (50)
Dysmotility	15 (19)	11 (28)	1 (10)	2 (9)	1 (13)
Mechanical obstruction	15 (19)	10 (25)	1 (10)	3 (14)	1 (13)
Combined	21 (26)	14 (35)	1 (10)	4 (18)	2 (24)
Fistula	2 (2)	-	2 (20)	-	-
Mucosal disease	1 (1)	1 (2)	-	-	-

Other	1 (1)	1 (2)	-	-	-
mGPS (0-2)					
mGPS=0	34(42)	15 (38)	1(10)	12 (55)	6 (75)
mGPS=1	10 (13)	3 (7)	3 (30)	4 (18)	-
mGPS=2	35 (44)	22 (55)	5 (50)	6 (27)	2 (25)

Data are presented as median and range, Numbers and percentages.

[a] *Upper GI cancer: Pancreas (12), gastric (16), NET (7), oesophageal (3), liver (2)*

[b] *Lower GI cancer: colon (7), rectum (9)*

[c] *Gynaecologic cancer: ovarian (19), uterine (2), vaginal (1)*

[d] *Other cancer: GIST (3), pulmonal (2), mamma (1), prostate (1), unknown (1)*

[e] *mGPS=(0=albumin>35,crp<10, 1=CRP>10, albumin>35, 2= CRP>10, Alb<35)*

Table 1 Socio demographics and clinical characteristics of study participants

N (%) Median (Range)	All (N=80)	Upper GI (N=40)	Lower GI (N=10)	Gynaecological (N=22)	Other (N=8)
BMR (basal metabolic rate)	1325 (1016-1931)	1354 (1021-1931)	1338 (1056-1626)	1251 (1051-1736)	1368 (1016-1645)
Daily intravenous energy(kcal) (N=73)	1140 (106-2754)	1140 (106-2754)	1373 (711-2640)	1325 (106-2270)	1325 (800-1710)
Energy (kJ/kg/day) (N=73)	90.4 (7.4-194.9)	89.6 (8.7-162.3)	100.3 (60.7-184.1)	85.8 (7.4-194.9)	99.7 (47.1-122.3)
Daily intravenous protein (g) (N=70)	49.6 (22-100)	48.4 (22-89)	50.0 (34-90)	54.5 (25-100)	44.3 (38-66)
Proteins (g/kg/day) (N=70)	0.87 (0.43-1.92)	0.88 (0.43-1.25)	0.86 (0.59-1.92)	0.92 (0.49-1.69)	0.78 (0.54-1.14)
Daily intravenous fluids (ml)	1536 (143- 4000)	1286 (429-3571)	2000 (143-3857)	2074 (429-4000)	1857 (1000-2500)
Fluids (ml/kg/day)	25.5 (3.0-62.6)	21.9 (7.7-58.8)	32.6 (3.0-60.8)	34.3 (5.5-62.6)	28.4 (12.2-38.5)
Type of catheter at discharge					
tCVC[a]	65 (81)	35(88)	7 (70)	18 (82)	5 (63)
CVC[b]	3 (4)	0 (-)	0 (-)	1 (5)	2 (25)
Port[c]	8 (10)	3 (7)	3 (30)	2 (8)	0 (-)
PICC[d]	4 (5)	2 (5)	0 (-)	1 (5)	1 (12)
Type of catheter (ALL)					
tCVC[a]	97 (69)	48 (79)	9 (48)	34 (67)	9 (75)
CVC[b]	21 (15)	7 (11)	5 (26)	7 (13)	2 (17)
Port[c]	11 (8)	3 (5)	4 (21)	4 (8)	0 (-)
PICC[d]	11 (8)	3 (5)	1(5)	6 (12)	1(8)
N catheters pr. patient (%)					
1 catheter	45 (56)	26 (65)	4 (40)	8 (36)	7 (87)

2 catheters	20 (25)	8 (29)	4 (40)	7 (32)	1 (13)
>2 catheters	15 (19)	6 (15)	2 (20)	7 (32)	-
Catheter handling (%)					
Home care nurse	50 (63)	24 (60)	6 (60)	13 (59)	7 (88)
Patient	21 (26)	11 (27)	2 (20)	7 (32)	1 (12)
Relative	9 (11)	5 (13)	2 (20)	2 (9)	-

[a] *tCVC: tunnelled central venous catheter.*

[b] *CVC: central venous catheter*

[c] *Port: totally implantable venous access device*

[d] *PICC: Peripherally inserted central catheter*

Table 2 Parenteral nutrition and central venous catheters

Outcome	All	Upper GI	Lower GI	Gynaecological	Other
Median (range), N (%)	N=80	N=40	N=10	N=22	N=8
Median HPS days	364.9	279.5	278.6	598.1	256.4
	(6-2006)	(6 - 1853)	(13 -1321)	(8- 2006)	(6 - 782)
Total HPS days	29.191	11.178	2804	13.158	2051
Overall HPS time					
<1 month	12 (15)	6 (15)	1 (10)	3 (14)	2 (25)
1m-6 months	27 (34)	19 (48)	3 (30)	2 (9)	3 (38)
6m – 1year	15(19)	5 (12)	5 (50)	4 (18)	1 (12)
1-2 years	13 (16)	6 (15)	-	6 (27)	1 (12)
>2 years	13 (7.5)	4 (10)	1 (10)	7 (18)	1 (12)
Complications					
ALL	58	16	8	32	2
CRBSI	47	11	8	26	2
Mechanical	12	5	1	6	-
Tunnel	1	-	-	1	-
Thrombosis	1	1	-	-	-
Complications (N=number of patients)	25 (31)	8 (20)	4 (40)	11 (50)	2 (25)
CRBSI (N=number of patients)					
None	60 (75)	34 (85)	6 (60)	14 (64)	6 (75)
1	11 (14)	3 (7.5)	3 (30)	3 (13)	2 (25)
>1	9 (11)	3 (7.5)	1 (10)	5 (23)	-
Complications pr. 1000 HPS days	1.38	1.38	0.83	2.03	0.36
CRBSI's Pr. 1000 HPS days	0.97	1.30	0.83	0.65	0.36
Mechanic Pr. 1000 HPS days	0.48	0.09	0.43	1.40	-
Re-admissions					
None	15	7	3	1	4
1 admission	14	9	2	3	0

2 admissions	13	7	1	4	1
3-7 admissions	27	13	3	8	3
8-17 admissions	11	4	1	6	0

Table 3 Treatment time, catheter related complications and re-admissionss

		Number	Survival		Crude model			Adjusted Model[a]	
		N	**Median survival (Range)**	**HR**	**95% CI**	**P**	**HR**	**95% CI**	**P**
mGPS[b]	0 +1(ref)	44	372 (39 - 2006)						
	2	35	43 (6-578)	5.10	3.02 - 8.62	<0.000*	4.66	2.65 – 8.20	<0.000*
Diagnose	Gynaecological (ref)	22	378.5 (8 -2006)						
	GI + other	58	113.5 (6-1853)	1.91	1.12 - 3.26	0.018*	1.90	0.98 - 3.62	0.054
Age	63 (25 – 83)	80	203 (6-2006)	0.97	0.94 – 0.99	0.035*	0.97	0.94 – 1.00	0.063
Sex	Men (ref)	27	144 (6 - 1484)						
	Women	53	243 (6 – 2006)	1.40	0.75-2.61	0.296	1.42	0.76 – 2.64	0.272
Pathophysiology	Other (ref)	54	58 (6 - 1513)						
	SBS	25	372 (22 - 2006)	0.48	0.29-0.82	0.006*	0.76	0.42 – 1.37	0.363

[a] *Multivariate Cox regression model adjusted for: mGPS, diagnose, age, sex, and pathophysiology.*

[b]*mGPS= Modified Glasgow Prognostic Score (0=albumin>35,crp<10, 1=CRP>10, albumin>35, 2= CRP>10, Alb<35)*

Table 4 Univariate and multivariate Cox regression survival analyses.