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# Evolution of parenteral nutrition practices in a comprehensive cancer center: Comparative audits

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## Résumé:

**Introduction:** La dénutrition touche 20 à 70% des patients atteints de cancer, selon l'âge du patient, le type et le stade du cancer. Deux Évaluations des Pratiques Professionnelles (EPP) ont été réalisées en 2016 et en 2019 afin d'évaluer la pratique de la Nutrition Parentérale (NP).

**Méthodes:** Les dossiers des patients adultes hospitalisés, qui ont reçu de la NP entre le 1er janvier 2018 et le 30 avril 2019 ont été analysés rétrospectivement. Vingt critères d'évaluations ont été définis. Nous avons effectué des analyses statistiques pour comparer les données entre les deux EPP.

**Résultats:** Entre le 1er Janvier 2018 et le 30 Avril 2019, 86 hospitalisations avec une prescription de NP ont été analysées. Sur les 69 patients, 66% étaient des femmes, l'âge moyen et médian était de 60 ans. Il s'agissait le plus souvent de patients d'oncologie médicale le plus souvent en soins palliatifs. Les tumeurs gynécologiques et digestives représentent les deux principales localisations tumorales. Le syndrome occlusif et la prise en charge pour soins palliatifs étaient les deux motifs principaux d'hospitalisation. L'évaluation du statut nutritionnel, les apports énergétiques totaux, la surveillance et la durée de la NP restent associés à de mauvais résultats.

**Conclusion:** Notre étude semble objectiver une amélioration de la pertinence de l'indication de la NP, de la prescription et du suivi des patients grâce à l'informatisation de la prescription et de la formation des professionnels. La NP reste souvent prescrite en situation palliative exclusive. Nous devons poursuivre nos améliorations, en particulier, l'évaluation clinique et biologique initiale ainsi que la surveillance. Il faut une équipe de référence pour améliorer la prise en charge des patients traités par NP.

Mots clés: Nutrition parentérale, cancer, dénutrition, Évaluation des Pratiques  
Professionnelles, soins palliatifs.

## Abstract:

**Introduction:** Malnutrition affects 20% to 70% of oncology patients depending on the patient's age, type and stage of cancer. Two audits were carried out in 2016 and 2019 to evaluate the practice of Parenteral Nutrition (PN).

**Methods:** Records of adult medical inpatients who received PN between January 1, 2018 and April 30, 2019 were retrospectively analysed. Twenty criteria were defined. We conducted a statistical analysis to compare the two audit data.

**Results:** Between January 1, 2018 and April 30, 2019, 86 hospitalizations with a PN prescription were analysed. Of the 69 patients, 66% were female, the mean and median age was 60 years. These were most often medical oncology patients in palliative care.

Gynecological and digestive tumors were the two main tumor localization. Bowel obstruction and palliative care management were the two main reasons for hospitalization. Nutritional assessment, amount of energy prescribed, monitoring, and duration of PN remain with poor results.

**Conclusion:** Our study seems to show improvements in the relevance of PN indications, the prescription, and monitoring in patients due to the computerization of prescription and training of professionals. PN remains often prescribed in exclusive palliative situations. We need to continue our improvements, particularly for the initial clinical and biological assessment, and the monitoring. It requires a referral team to improve management of patients treated with PN.

**Keywords:** Parenteral nutrition, cancer, malnutrition, audit, palliative care.

## **Introduction**

The goal of supportive and palliative care, including nutritional care, is to address the needs of patients with cancer and thus enhance quality of life (1,2). Malnutrition affects 20% to 70% of oncology patients depending on the patient's age, type and stage of cancer (3).

Numerous studies have highlighted the consequences of malnutrition in patients with cancer, including adverse impact on survival, added healthcare costs (3), impaired functional status (4–6), and accounts for up to 20% of cancer deaths (7–9). Once admitted into the hospital, patients with cancer are at high risk for further deterioration of the nutritional status due to fasting for diagnostic studies, treatment side-effects and overall sub-optimal nutritional management (1). The use of individualised nutritional support improves survival and other functional outcomes especially in the short term (1). According to international recommendations (10), a patient suffering from cancer, non-malnourished but reporting low food intakes, or moderately malnourished with normal food intakes should receive advice on fortifying his diet and oral nutritional supplements (ONS). A patient suffering from cancer, severely malnourished, or moderately malnourished with low food intakes, should receive artificial nutrition: enteral nutrition (EN) or, if not sufficient or possible, parenteral nutrition (PN) (1,10). EN should be preferred to PN, as associated with fewer complications, particularly in oncology patients (11, 12). PN is indicated for patients with moderate to severe malnutrition, having an unusable or inaccessible small intestine or after failure or refusal of EN after clear and detailed information on the benefits of EN (13).

Complications of PN are multiple and can sometimes be fatal (hydroelectrolytic disorders, refeeding syndrome, central venous catheter infection, hyperglycemia, dyslipidemia, hepatic steatosis leading to secondary biliary cirrhosis in case of home PN etc.).

The clinical monitoring of a patient under PN is important and requires good cooperation between the medical and paramedical staff. The proper use of PN therefore requires the application of the recommendations of good practice. Numerous learned societies of nutrition, such as the French speaking Society for Clinical Nutrition and Metabolism (SFNCM), the European Society for Clinical Nutrition and Metabolism (ESPEN), and the National Institute for Health and Care Excellence (NICE), have established recommendations concerning the indications, the modalities of prescription and monitoring of PN (10,14,15). Five studies, conducted in French and Geneva university hospitals and comprehensive cancer centers, in departments of surgery, medicine and gynecology, showed that recommendations of good practice in PN, were insufficiently respected. The prescription of PN was justified and relevant in 86%, 73%, 96%, 53% and 96%, according to data from Nardo and al (16), Thibault et al (17), Malbranche et al 2007 (18), Som et al (19), Saintes et al 2016 (20), respectively. Compliance with recommendations for the addition of vitamins, trace-elements and calories was 20%, 10% and 60% respectively.

The SFNCM put forward an Evaluation of Professional Practices (EPP) in clinical nutrition entitled "Parenteral Nutrition in Adult Short-stay Hospitalized Patients, February 2012"(20). On this basis, an audit has been carried out in 2016 at the Centre Eugène Marquis (CEM), a private health comprehensive cancer center of collective interest in Rennes, France (19). This audit showed a lack of pre-therapeutic nutritional assessment, low relevance of PN indication, poor quality of prescription, clinical and biological monitoring.

Since the publication of this first audit, the CEM has implemented actions and recommendations in order to improve the management of patients treated with PN: computerized and protocolized prescription, institutional quality approach, training of professionals, personalized approach to the patient.

Therefore, the objective of the present study was to assess the relevance of PN use in our center, using the same audit methodology than in 2016, to measure the impact of our corrective measures by comparing 2016 and 2019 audit data.

## **Patients and Methods**

### **2.1. Patient selection**

All medical records of adult patients who received PN at the CEM between January 1, 2018 and April 30, 2019 were retrospectively analysed. The register included the dates of stay during which the patient had received PN, and, the details of the PN prescription: identification of the product, calories and volume, days and hours of administration, with or without vitamins and trace-elements. All PN prescriptions were computerized.

### **2.2. Data collection**

The data were collected retrospectively by a physician and supplemented by the computerized information in the care record, medical prescriptions and nursing chart.



In addition to the SFNCM assessment criteria, were collected the patient's demographic characteristics, the main reason for hospitalization, the localization of the cancer, the PN prescription: exclusive PN or not, and whether or not a consultation with a dietician was carried out during the stay.

### 2.3. Statistical analysis

The results were expressed as a number and percentage of the total number of patients for whom the information was available. We conducted a statistical analysis to compare the data between the 2016 and 2019 audits. The analysis was performed for each criterion using Fisher's exact test. A P value  $<0.05$  was considered as statistically significant.

### 2.4. Evaluation criteria as per the recommendations of the SFNCM

The SFNCM defined twenty criteria (21) for evaluating the institutional quality approach, the quality of the initial assessment, indication, prescription, and PN monitoring. Practices were evaluated according to these recommendations. Any deviation from the criteria of good practice, for each category of recommendation, was considered an adverse event. The sum of the data for each patient, by recommendation category, is related to the total number of patients, to establish the percentage of compliance with the recommendations. We examined whether the CEM had deployed sufficient institutional resources to promote good parenteral nutrition practices.

#### 2.4.1. Institutional quality approach

This included all procedures, protocols, and training plans that the institution was implementing to provide the quality of the PN prescription.

#### 2.4.2. Quality of the indication

Good recommendations include parenteral nutrition prescribed in situations where enteral nutrition was contraindicated, insufficient to meet energy requirements, or was poorly tolerated or withheld.

#### 2.4.3. Quality of the initial assessment

Of note, our study was performed before the publication in 2019 and 2021 by the French Haute Autorité de Santé (HAS) of new recommendations for the diagnosis of malnutrition in France for adults and older people (22,23). Assessment of nutritional status should include weight at the time of prescription, weight loss in 1 month and 6 months before, height and body mass index. This makes possible to identify whether the patient was severely malnourished and therefore at risk of refeeding syndrome (RS) at the onset of PN.

Good practices include biological pre-therapeutic assessment including blood ionogram, phosphoremia, magnesemia, urea and creatininemia to highlight severe malnutrition and screen for RS ; metabolic abnormalities measured by capillary or venous glycaemia, triglyceridemia and liver function tests and correction and monitoring of electrolyte disorders are essential before starting the PN.

#### 2.4.4. Quality of the prescription

Energy intakes prescribed and administered by PN alone are considered adequate between 20 and 35 kcal/kg/day. Protein intakes prescribed and administered by PN alone are considered adequate between 0.625 and 1.87 g protein/kg/day. The addition of vitamins and trace-elements is indispensable in association with PN solutes, as the latter did not contain them for physico-chemical stability reasons.

The foreseeable or actual duration of central venous PN should be greater than seven days, as the clinical benefit of PN is not proven for a shorter duration.

#### 2.4.5. Quality of monitoring

Efficiency and safety of PN are assessed, clinically (hydration, catheter inspection and temperature, daily; weight, twice weekly) and biologically (capillary or venous glycaemia, blood ionogram with phosphoremia, magnesemia, twice weekly; transaminases, gamma-GT, alkaline phosphatases, total bilirubin, conjugated, once weekly).

### **Results**

#### **3.1 Patients characteristics**

Between January 1, 2018 and April 30, 2019, 86 hospitalizations records with a PN prescription at the CEM were analysed. These 86 hospitalizations records involved 69 patients. There were 11 prescriptions out of 86 prescriptions where the patient was already on PN when entered the department. Of the 69 patients in the study, 66% were female (n=57/86), the mean and median age was 60 years (standard deviation: 12 ; extremes: 19-

80). The population for this study was comparable to the 2016 study (Table 1). PN was exclusive in 27% of cases (n = 23/86). Tumour localization is reported in Table 1. PN was prescribed in a context of bowel obstruction in 52% of cases and in a palliative or end-of-life context in 14%. Main reason for hospitalisation is reported in Table 2.

### 3.2 Criteria of approach-institutional quality

The CEM has implemented a new institutional quality approach to comply in 100% of cases with the recommendations of good practice in PN (Table 3). This by implementing new procedures, creating protocols, training the staff and updating the prescription software to improve the quality of PN prescription.

### 3.3 Criteria for appropriateness of indication

The PN indication is considered appropriate in 81% of cases (Table 4).

EN was indicated at first intention (or refused after clear information) in 19% of cases because the gastro-intestinal tract was functional. However, EN was only prescribed in 10% of cases.

The PN prescriptions were not relevant in 10 % of the cases: absence of proven malnutrition (or high risk of malnutrition), end-of-life care, emergency care.

### 3.4 Quality criteria for the initial assessment

A consultation prior to the initiation of PN by the dietician was carried out in 24% (n=21/86) of cases. All the pre-therapeutic clinical data (weight at the time of the prescription and one month and six months before, height, Body Mass Index) was reported in 45% (n=39/86) of cases (Table 7.3).

The biological evaluation was incomplete: blood ionogram including phosphoremia and magnesemia was carried out in 49% of cases (n=42/86). Triglyceridemia was measured 3% of cases (n = 3/86).

### 3.5 Quality criteria of the prescription

Prescription writing rules were fully complied within 100% of cases with accurate identification of the prescriber, hours of administration, and type of product prescribed (Table 5).

Several prescription errors persist: absence of prescription of trace-elements and vitamins in 2% of cases, inadequate calorie intake in 36% of cases and inadequate protein intake in 17% of cases (Table 5). The mean duration of the PN was 12,5 days and of more than seven days in 69% of cases (versus 77% in 2016) (Table 7.3).

Of the 31 PN prescriptions below 20 kcal/kg/day, 22 had no reason reported, four were related to an intolerance or a side effect preventing the PN increase, three were related to a medical prescription of PN decrease, one PN was relayed by EN and one had no PN increase in the face of a suspicion RS.

### 3.6 Monitoring quality criteria

The quality of PN monitoring was poor (Table 6). The audit revealed significant insufficiency in the clinically and biological monitoring of PN (sodium retention, RS, hydroelectrolytic disorders, hyperglycaemia, liver test abnormalities, hypertriglyceridemia). Biological monitoring by ionogram and liver function tests were respectively 35% and 59%. The surveillance of the central venous catheter infection risk was 3,5%.

For patients with PN for more than one month, follow-up by a physician nutritionist or dietician was performed in 5.8%.

### 3.7 Comparison of audit 2016 and 2018-2019:

The comparison of results between the two audits about cancer localization, reason for hospitalization and PN prescription, appropriateness of indication, duration of PN prescription, implementation of institutional measures are presented in Table 7.

All the statistical analysis of the comparison between the 2016 and 2019 audits are presented in Table 7.

The prescription of PN seems more appropriate in 2019 according to the reason for hospitalization because PN was prescribed in a context of bowel obstruction in the majority of cases. The PN indication is considered more appropriate in 2019 than in 2016. The CEM has implemented more institutional resources in 2019 than in 2016 to support good practices in NP. The clinical initial evaluation is insufficient and lower in 2019 than in 2016. None of the difference between 2016 and 2019 were significant in accordance with the initial biological assessment criteria. Prescription writing rules were improved in 2019

compared to 2016. A Significant improvement in micronutrient supplementation is observed in 2019. There was a significant improvement in biological monitoring by ionogram and liver function tests in 2019 versus in 2016. There was a significant regression of the surveillance of the central venous catheter infection risk in 2019.

## **Discussion**

### **Improvements**

Our study reveals improvements in the relevance of PN indications, good practices of prescriptions, and monitoring in cancer patients. This suggests that proactive implementation of quality control measures might indeed translate into improved PN practices in cancer patients. The indications for PN are more relevant and the modalities of prescriptions are more consistent with the recommendations. One main improvement is a better practice towards the addition of micronutrient via the systematic computerization of prescriptions. There is also an improvement in biological monitoring. The criteria for an institutional quality approach are now fully met.

However, we need to understand our persistent errors and continue our improvements, particularly for the initial clinical and biological assessment, the adequacy of the prescriptions of energy and protein intakes to the needs (based on the patient's weight) and the clinical and biological monitoring. Particularly, the assessment for malnutrition should be systematically done in all cancer patients admitted to other center. The biological assessment before starting PN and for PN monitoring is a key element to prevent the refeeding syndrome.

The first audit suggested the use of an analogue verbal or visual scale for the assessment of food intake (19), but this is still not the case. The weight and nutritional status of cancer patients are very important for adjusting the amount of PN and these are insufficiently investigated. Weight loss in one month and in six months, loss of mass and/or muscle function should be investigated (3,20,22,23). Several nutritional evaluation scores are available (1,24,25). To prevent adverse clinical outcomes associated with malnutrition, the ESPEN recommends identifying cancer patients at nutritional risk through early screening (1,3,10).

### **Parenteral nutrition in palliative care**

PN should be prescribed for a patient whose nutritional status has correctly been assessed, a non-functional digestive tract, with a central venous line, associated with a curative or palliative oncology management project. There is never an emergency to initiate PN.

Artificial nutrition is too often prescribed in exclusive palliative situations or even at the end of life. Saintes et al included 3.7% of patients in exclusive palliative care and discontinuation of care or death was the primary cause of PN arrest, accounting for 39% of patients (20).

31% of patients in the study of Som et al were admitted for palliative care and end-of-life, primary reason for admission to hospital (19). SFNCM and ESPEN recommend that the indication for artificial nutrition should be reassessed on a case-by-case basis, in this context, considering the patient as a whole: general condition, cancer prognosis, potential benefits of nutritional support, patient expectations and wishes.

PN is far too often prescribed or continued because of the difficulty of correctly assessing the prognosis, but also of announcing this decision to the patient and his or her family (26).



PRONOPAL scores can be used to estimate patient survival and guide treatment decisions (27). Another study proposes the use of PG-SGA to better assess patient prognosis and thus inform the decision to prescribe or not a PN in palliative situations (28). PN has its place if the patient is at greater risk of dying from malnutrition than from tumor progression, in peritoneal carcinosis with malignant bowel obstruction for example (29).

Data on the benefits of PN in patients with advanced cancer cachexia on quality of life are contradictory. The phase III study of Bouleuc et al (30) found that PN improved neither quality of life nor survival and induced more serious adverse events than oral feeding but the small number of patients, a selection bias, and a shorter median overall survival than expected may explain these results. Parenteral hydration does not improve survival or quality of life (31). Observational studies like Culine et al (32), Sowerbutts and al (33), Vashi and al (34), Cotogni and al (35), and a systematic literature review (36) found that correcting malnutrition using PN might have a significant benefit on patient well-being despite its potential negative impact on family caregivers, quality of life, performance and nutritional status. We remind that parenteral nutrition increases infectious risk especially on central venous catheter and induces more deleterious hospitalizations in palliative patients (37). Other prospective randomised trials should be done in patients with advanced cancer, including more homogeneous patient groups, stratified according to type of cancer and treatment, in order to evaluate in which clinical situation the use of PN should be beneficial.

### **Futur enhancements**

The computerization of prescriptions has led to an initial improvement in prescribing procedures. The system could be further improved: when a physician prescribes a PN, the

computerized tool could request the pre-therapy clinical and biological data. PN is a specific treatment that requires a referral team with a referring physician within a health care institution. This team must be alerted using computer devices for example, if artificial nutrition, particularly PN, is initiated, in order to check the relevance of this prescription and to advice on the next steps to be taken. The follow-up of patients on PN is not optimal and requires, at the initiation of PN, an appointment with a dietician, and after one month of treatment, with a nutritionist physician. Oncology patients have their consultation, chemotherapy and radiotherapy appointments scheduled by a programming nurse. PN follow-up could follow the same pattern. Associated with this personalized follow-up, monitoring biology in a systematic and anticipated manner will allow for optimal management of patients treated with PN.

A smartphone application could help to optimize the patient follow-up, to ensure monitoring of patients treated by a PN: biological follow-up, symptom records, reminders of follow-up appointments. Some results show that there is no improvement for several criteria between 2016 and 2019, particularly for the initial assessment and clinical monitoring. Training of medical and paramedical staff on PN, its benefits, risks, associated care and management recommendations must be increased.

We could change our organization of care about PN with a better integration of palliative care, and we should also decide the interest of PN in palliative situations in multidisciplinary staff with a referral team in artificial nutrition as recommended by Senesse and al (38). It would be relevant to include a criterion in the audit about multidisciplinary discussion of the interest of PN, especially in palliative situations, as recommended by the SFNCM (13).

## Limits

The meta-analysis of Bozzeti and al (39) describes that there is absence of evidence of benefits of the supplemental PN during oncologic management, in particular when systemic therapies are involved. Further prospective, randomized studies in specific populations are needed. From the practical point of view, a nutritional support should be considered when severe malnutrition caused by the disease or following repeated oncologic treatments can make the patients poorly compliant or tolerant (because of increased side effects) with further chemotherapy cycles, as recommended by the international guidelines.

Our study has limitations. More than 10% of the patients already had a PN when they entered the department and therefore should not be managed by us for the nutritional pre-therapeutic evaluation, consultation with a dietician, and monitoring: this was detrimental to our results. The data collection was not carried out by the same physician, which may explain some of the differences between the two audits particularly on the regression of the assessment of the infectious risk.

## Conclusion

There is still room for improvement in the prescription and management of PN.

An important enhancement to expect is the intervention of a nutritionist physician once a week at the CEM. It appears necessary to potentiate physicians' information, dieticians' intervention and computer tools to optimize initial assessment and clinical and biological

management under PN. Another point of improvement remains the relevance of PN since there are still too many prescriptions for PN compassionately.

A new audit could be carried out after corrective measures.

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Abbreviations:

CEM: Centre Eugène Marquis ; EN: Enteral Nutrition ; ESPEN: the European Society for Clinical Nutrition and Metabolism ; HAS: The French Haute Autorité de Santé ; kcal: kilocalories ; kg: kilogram ; NICE: The National Institute for Health and Care Excellence ; ONS: Oral Nutritional Supplements ; PN: Parenteral Nutrition ; RS: Renutrition Syndrome ; SFNCM: Société Française de Nutrition Clinique et Métabolique

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## Tables

Table 1: Population characteristics in 2019

Variables	N = 69 <sup>1</sup>
Age	60 (12)
Sex Female	57 (66%)
Sex Male	29 (34%)
Tumor localization	
Gynecological tumours	29 (42%)
Digestive tumours	23 (33%)
Urological tumours	8 (12%)
Skin tumours	3 (4%)
Head and Neck tumours	2 (3%)
Others	4 (6%)

<sup>1</sup>Mean (SD); N (%)

SD: Standard Deviation

Table 2: Main reasons for hospitalization in 2016 and 2019

	In 2016 N= 49 <sup>1</sup>	In 2019 N = 86 <sup>1</sup>
Palliative care and End-of-Life Care	19 (40)	12 (14)
Post-chemotherapy diarrhea	6 (12)	1 (1)
Occlusion / Sub-occlusion	5 (10)	44 (52)
Analgesic management	4 (8)	6 (7)
Malnutrition	3 (6)	2 (2)
Dysphagia	3 (6)	1 (1)
Febrile Aplasia	2 (4)	2 (2)
Carcinomatous meningitis	2 (4)	2 (2)
Tumor Progression	2 (4)	4 (5)
Others	3 (6)	12 (14)

<sup>1</sup>N (%)

Table 3: Criteria of approach-institutional quality in 2016 and in 2019

	Responses in 2016	Responses in 2019
There is a procedure or <i>modus operandi</i> describing how to prescribe, specifying the indications, level of intake and how to monitor parenteral nutrition.	No	Yes
A multi-year training plan is defined in order to ensure the quality and safety of the patient's drug management including parenteral nutrition.(article 7 of the decree of 6/04/2011).	No	Yes
A pharmaceutical validation of the prescription of parenteral nutrition, which is to be considered as a medicinal product at risk, shall be organised.	Yes	Yes
The institution implements means enabling parenteral nutrition to be prescribed in accordance with Article 13 of the Order of 6/04/2011 on the prescription of medicines.	No	Yes

The CEM has implemented several protocols, procedures, and training to improve the quality of PN prescription.

Table 4: Criteria for appropriateness of indication in 2019

Variable	N = 86 <sup>1</sup>
Non-functional digestive tract (Yes)	70 (81)
EN was indicated at first intention	16 (19)

<sup>1</sup>N (%)

Table 5: Quality criteria of parenteral nutrition prescription in 2019 (N = 86)

	Yes N <sup>1</sup>	No N <sup>1</sup>
Compliance with the rules for drafting the prescription	86 (100)	0 (0)
The energy intake prescribed and administered alone is adapted to the patient, between 20 kcal/kg/day and 35 kcal/kg/day	55 (64)	31 (36)
Total energy intake :	31 (36)	55 (64)
- Strictly < 20 kcal/kg/day		
- Strictly > 35 kcal/kg/day	0 (0)	89 (100)
Protein intakes prescribed and administered by parenteral nutrition alone are adapted to the patient	71 (83)	15 (17)
the addition of vitamins and trace elements are prescribed and administered	84 (98)	2 (2)
Predicted or actual duration of parenteral nutrition by central venous catheter is greater than 7 days.	59 (69)	27 (31)

<sup>1</sup>N (%)

Criteria which define the quality of the PN prescription

Table 6: Quality criteria for parenteral nutrition monitoring in 2019 (N= 86)

	Yes N <sup>1</sup>	No N <sup>1</sup>
Appropriate monitoring of the water balance is prescribed and carried out: diuresis and recording of total and intravenous daily water intake at intervals adapted to the patient's condition.	1 (1)	85 (99)
Daily monitoring of the infectious risk is prescribed and carried out: daily thermal curve and inspection of the cutaneous entry point of the venous catheter.	3 (3)	83 (97)
Weight monitoring is prescribed and carried out at least twice a week.	19 (22)	67 (78)
Appropriate monitoring of venous and/or capillary blood glucose levels under parenteral nutrition is prescribed and carried out.	8 (9)	78 (91)
A blood ionogram with natraemia, kalaemia, phosphoremia, magnesemia is prescribed and carried out at least twice a week	30 (35)	56 (65)
A complete liver biology (transaminases, alkaline phosphatases, gamma-GT, total and conjugated bilirubin) is prescribed and performed at least once a week	51 (59)	35 (41)
The patient is followed by a medical nutritionist (or a dietician if trained) when the foreseeable or actual duration of parenteral nutrition is more than one month.	5 (71)	2 (29)

<sup>1</sup>N (%)

Criteria which define the quality of the PN monitoring

Table 7.1: Comparison the audit of 2016 versus 2019 about cancer localization, reason for hospitalization and PN prescription, duration of PN prescription, implementation of institutional measures.

	2016	2019
First localization	Gynecological tumors (43%)	Gynecological tumors (42%)
Main reason for hospitalization	Palliative and End-of-Life Care (31%)	Bowel obstruction (52%)
Criteria of approach-institutional quality	yes for 25% of the criteria	yes for 100% of the criteria
Average length of PN (in days)	11	12.5

Table 7.2: Comparison the audit of 2016 versus 2019 about appropriateness of indication

Variable	2016, N = 49 <sup>1</sup>	2019, N = 86 <sup>1</sup>	p-value <sup>2</sup>
Non-functional digestive tract (Yes)	26 (53%)	70 (81%)	<0.001

<sup>1</sup>N (%)

<sup>2</sup>Fisher's exact test

Statistical difference between the two audits on the PN appropriate indication

Table 7.3: Comparison the audit of 2016 versus 2019 about quality of initial assessment

Variable	2016, N = 49 <sup>1</sup>	2019, N = 86 <sup>1</sup>	p-value <sup>2</sup>
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Nutritional status are completed in the patient record (Yes)	31 (63%)	39 (45%)	0.051
A blood ionogram is prescribed and performed before the start of the PN (Yes)	0 (0%)	3 (3.5%)	0.55
The prescription is written after examination of the hospitalized adult (Yes)	8 (16%)	86 (100%)	<0.001
The energy intakes prescribed and administrated by PN alone are adapted to the patient (Yes)	30 (61%)	55 (64%)	0.85
The protein intakes prescribed and administrated by PN alone are adapted to the patient (Yes)	44 (90%)	71 (83%)	0.32
Vitamins and micronutrient supplementation is prescribed and administrated (Yes)	42 (86%)	84 (98%)	0.011
The anticipated or effective duration of central venous PN is greater than 7 days (Yes)	36 (77%)	59 (69%)	0.042
Adequate monitoring of water balance is prescribed and carried out (Yes)	1 (2.0%)	1 (1.2%)	>0.99

<sup>1</sup>N (%)

<sup>2</sup>Fisher's exact test

Statistical difference between the two audits on the quality of the initial assessment

Tables 7.4: Comparison the audit of 2016 versus 2019 about quality of monitoring

Variable	2016, N = 49 <sup>1</sup>	2019, N = 86 <sup>1</sup>	p-value <sup>2</sup>
Daily monitoring of the infectious risk is prescribed and carried out (Yes)	47 (96%)	3 (3.5%)	<0.001
Weight monitoring is prescribed and performed at least twice a week (Yes)	15 (31%)	19 (22%)	0.31

Appropriate monitoring of blood glucose levels under PN is prescribed and carried out (Yes)	27 (55%)	52 (60%)	0.59
A blood ionogram with phosphoremia and magnesemia is prescribed and performed at least twice a week (Yes)	2 (4.1%)	30 (35%)	<0.001
Transaminases, gGT, phosphatases, alkaline, total and conjugated bilirubin are prescribed and performed at least once per week (Yes)	9 (20%)	51 (59%)	<0.001
Patient is followed by a physician nutritionist where anticipated or effective duration of the PN is more one month			
No	7 (14%)	2 (2.3%)	
Not Applicable	37 (76%)	79 (92%)	
Yes	5 (10%)	5 (5.8%)	

<sup>1</sup>N (%)

<sup>2</sup>Fisher's exact test

Statistical difference between the two audits on the quality of the monitoring

