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ORIGINAL ARTICLE

Prevalence of hospital malnutrition in cancer patients: a sub-analysis of the PREDyCES® study

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Abstract
Purpose In oncology patients, hospital malnutrition is associated with a greater risk of morbidity and mortality. The objective of this study was to determine the prevalence of nutritional risk and the clinical and economic consequences of hospital malnutrition in oncology patients hospitalised in Spanish centres.
Methods This was an observational, cross-sectional, multicentre study. The prevalence of nutritional risk was determined using the Nutrition Risk Screening®-2002 (NRS®-2002).
Results Four hundred one oncology patients were included; 33.9 % (136/401) were at nutritional risk (NRS®-2002 ≥ 3) at admission and 36.4 % (135/371) at discharge. On average, patients at nutritional risk were more elderly and had lower weights, body mass indices and arm and calf circumferences, as well as lower serum albumin levels than patients not at risk. Mean duration of hospitalisation and healthcare costs were greater in patients at nutritional risk at discharge (12.1 days; 95 % confidence interval (CI) 10.83–13.39) than in well-nourished patients (8.6 days; 95 % CI 7.86–9.40). Only a third of the patients at risk of malnutrition at discharge had received any kind of nutritional support.
Conclusions This study shows that hospital malnutrition is a prevalent and undertreated condition in oncology patients that is associated with longer hospital stays and increased healthcare costs.

Keywords NRS®-2002 · Hospital malnutrition · PREDyCES · Oncology · Spain

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Introduction

Hospital malnutrition (HM) is a prevalent condition with major clinical and economic consequences [1, 2]. In oncology patients, HM has been associated with a greater risk of complications [3, 4], longer hospital stays [5], poorer tolerance and response to treatments [6], lower survival [7, 8] and a significant decline in patients' quality of life [9–12].

The aetiology of malnutrition in cancer patients is complex. Some factors, such as the presence of metabolic disorders related to the neoplastic process, insufficient nutrient intake and a high incidence of adverse gastrointestinal effects including mucositis, diarrhoea and nausea have been related to alterations in the nutritional status of oncology patients [13, 14]. Cachexia, a metabolic process closely related to malnutrition and characterised by rapid weight loss due to depletion of fatty tissue and muscle mass, affects 80 % of patients with advanced disease and is responsible for more than 30 % of the deaths of cancer patients [15].

Although nutritional status generally worsens as the disease progresses and with the administration of cytotoxic treatments [16–19], malnutrition can appear at any time during the disease, even at diagnosis [20]. It is not in vain that anorexia and weight loss with no apparent cause are reasons to suspect

the presence of a tumour. Moreover, the presence of nutritional deficits in the initial stages of the disease can affect the tolerability of chemotherapy [21].

In a study conducted in 3047 patients with different types of tumour, between 31 and 87 % of the patients experienced weight loss before receiving chemotherapy [22]. In another study in patients with gastrointestinal tumours, 70 % of patients with tumours in the lower intestinal tract, 78 % of patients with oesophageal or stomach cancer and 87 % of patients with pancreatic tumours presented weight loss at diagnosis [20]. In a study conducted in Spain in patients with metastatic or advanced cancer in which 60 % of them were receiving chemotherapy or radiotherapy, malnutrition prevalence rates were over 50 % according to the Patient-Generated Subjective Global Assessment (PG-SGA) [23].

Despite the importance of malnutrition for the clinical evolution of oncology patients, there is not yet a universally accepted standard method for evaluating malnutrition in such patients. In hospitalised patients, the European Society for Clinical Nutrition and Metabolism (ESPEN) recommends the use of the NRS®-2002, a tool that includes diagnosis of cancer as a risk factor for malnutrition [24].

The objectives of this study are to determine the prevalence of nutritional risk in oncology patients hospitalised in Spain using the NRS®-2002 tool, analyse the clinical characteristics of these patients at admission and discharge, and evaluate the clinical and economic consequences of malnutrition in this population.

Materials and methods

Study design

This study evaluated the prevalence of nutritional risk in the subgroup of patients diagnosed with oncological disease in the PREDyCES® study. The PREDyCES® study was an observational, cross-sectional, multicentre study conducted in sites all over Spain from April to September 2009. The design, inclusion and exclusion criteria of the PREDyCES® study have been described in detail in previous publications [25, 26].

Variables

Sociodemographic data, anthropometric measurements (weight, height, arm and calf circumference), and anthropometric measurements and biochemical parameters were collected at admission and discharge.

The nutritional status was evaluated by the NRS®-2002 tool at admission (in the first 48 h after admission) and at discharge (or 28 days after admission if duration of hospitalisation was ≥28 days). The prevalence of nutritional risk (percentage of oncology patients included in the PREDyCES® study with an NRS®-2002 score ≥3) was determined at both admission and discharge for all the oncology patients and for subgroups of oncology patients according to tumour, sex and age.

Sample size and statistical analysis

The sample size was determined by the number of oncology patients who participated in the PREDyCES® study. In the PREDyCES® study, the sample size was calculated from malnutrition prevalence data in previous studies conducted in Spain [26].

A descriptive data analysis was performed. The mean, standard deviation and 95 % confidence intervals (CIs) for the mean were calculated for the continuous variables. Relative and absolute frequencies were calculated for the categorical variables.

The differences between the anthropometric measurements at admission and discharge were evaluated by the Wilcoxon signed-rank test. The differences in the prevalence of nutritional risk according to age (<70 vs. ≥70), sex and type of admission (scheduled or urgent) were evaluated by Fisher's exact tests. The differences in mean age, biochemical parameters and anthropometric measurements between patients with and without malnutrition risk were evaluated by *t* tests. In all the analyses, the statistical significance threshold was set at $p < 0.05$.

Severe weight loss was defined as reduction of more than 2, 3, 4 or 5 % of patients' initial weight during hospital stays of up to 10, 20, 30 days or more than 30 days, respectively.

Length of in-hospital stay (LOS) was calculated by the patients' dates of admission and discharge. Hospitalisation costs were calculated from the days of hospitalisation and the average cost per day of admission provided by the Ministry of Health and Consumer Affairs.

Statistical analysis was performed with SPSS® 15.0 for Windows (SPSS Inc., Illinois, United States).

Ethical considerations

The PREDyCES® study was approved by the Hospital Universitario La Paz ethics committee and conducted following the principles of the Declaration of Helsinki and the 1996 International Conference on Harmonisation Good Clinical Practice standards. All the patients granted their informed consent in writing to participate in the PREDyCES® study.

Results

A total of 401 oncology patients were included; 206 (51.4 %) were admitted as scheduled and 195 (48.6 %) were admitted

Table 1 Body weight at admission and discharge

	Weight at admission; mean (SD)	Weight at discharge; mean (SD)	Mean difference between weight at admission and discharge (95 % CI)	*p*
Total	66.89 (16.13)	65.38 (15.39)	−1.83 (−1.12 to –2.54)	<0.001
<70 years	68.39 (16.52)	66.73 (15.40)	−1.65 (−0.69 to –2.62)	=0.001
≥70 years	64.56 (15.27)	63.20 (15.20)	−2.11 (−1.10 to –3.12)	<0.001

for urgent reasons. The departments to which most patients were admitted were general and gastrointestinal surgery (24.4 %), oncology (15.0 %), urology (14.0 %), haematology (13.0 %) and internal medicine (13.0 %). The most common types of tumour were lower gastrointestinal tract tumours (19.5 %); haematological neoplasms (16 %); head or neck tumours (8.5 %); respiratory tumours (8.0 %); tumours of the upper gastrointestinal tract (4.2 %) and tumours of the pancreas, liver or bile ducts (4.2 %).

Approximately one third of the patients (39.2 %) were 70 years of age or older at admission and the mean age ± standard deviation (SD) was 64.6 ± 14 years. Two thirds (61.6 %) of the patients were men.

Patients had a mean body weight of 66.89 ± 16.13 kg at admission and 65.38 ± 15.40 kg at discharge, with a significant mean difference of −1.83 kg between weight at admission and discharge ($p < 0.001$). Patients who were ≥70 years old exhibited a mean weight loss of 2.11 kg ($p < 0.001$) (Table 1).

Mean body mass index (BMI) was 24.70 ± 5.81 kg/m^2 at admission and 24.17 ± 5.65 kg/m^2 at discharge, with a significant mean difference of −0.67 kg/m^2 between BMI at admission and discharge ($p < 0.001$). Patients ≥70 years old had a mean reduction in BMI of 0.71 kg/m^2 ($p = 0.001$) (Table 2);

34.1 % of the patients lost 1 to 5 kg during hospitalisation and 8.8 % lost 5 kg or more. Weight loss was particularly significant in patients with higher LOS. There was severe weight loss in 48.4 % of the patients admitted for more than 20 days and 45.3 % of those admitted for 11 to 20 days;

33.9 % (136/401) of the patients were at nutritional risk (NRS®-2002 ≥ 3) at admission and 36.4 % (135/371) at discharge. In elderly patients (≥ 70 years), the prevalence of nutritional risk was 38.3 % (106/277) at admission and 50 % (74/148) at discharge.

The departments with the greatest prevalence of nutritional risk were oncology (50.0 %), haematology (46.2 %), internal medicine (40.4 %), otorhinolaryngology (36.8 %) and general and gastrointestinal surgery (36.7 %). All the patients aged ≥70 years admitted to respiratory, neurology and oncology departments and half or more than half of the patients aged ≥70 years admitted to haematology (87.5 %), general and gastrointestinal surgery (57.4 %) and gastroenterology (50.0 %) were at nutritional risk at admission.

When the results were analysed according to tumour location, the prevalence of nutritional risk at admission was 47.4 % (9/19) in patients with upper gastrointestinal tract tumours (oesophageal–gastric), 45.0 % (9/20) in patients with tumours of the pancreas, liver or bile ducts, 42.9 % (18/42) in patients with respiratory system tumours, 39.1 % (36/92) in patients with lower gastrointestinal tract tumours (bowel and colon) and 36.8 % (25/68) in patients with haematological neoplasms. At discharge, the prevalence of nutritional risk was 51.6 % (32/62) in patients with haematological neoplasms, 50.0 % (9/18) in patients with upper gastrointestinal tract tumours and 46.3 % (38/82) in patients with lower gastrointestinal tract tumours.

In comparison with the patients not at risk, the patients at risk of malnutrition at admission presented an older mean age, lower weight, BMI and arm and calf circumference and lower serum albumin levels (Table 3).

The mean LOS among patients at nutritional risk at discharge was 12.1 days (95 % CI 10.83–13.39), while among well-nourished patients, it was 8.6 days (95 % CI 7.86–9.40). Healthcare costs were also significantly higher in patients at risk (€8596; 95 % CI €7605.53–9585.98) compared to patients not at risk (€6652; 95 % CI €5961.79–7643.70) ($p = 0.001$) (Fig. 1).

66.7 % of the oncology patients at nutritional risk at discharge had not received nutritional support during hospitalisation. This percentage increased to 73.0 % in the group of patients 70 years of age or older (Fig. 2).

Table 2 Body mass index (BMI) at admission and discharge

	BMI at admission; mean (SD)	BMI at discharge; mean (SD)	Mean difference between BMI at admission and discharge (95 % CI)	*p*
Total	24.70 (5.81)	24.17 (5.64)	−0.67 (−0.39 to –0.94)	<0.001
<70 years	24.79 (5.92)	24.11 (5.71)	−0.64 (−0.26 to –1.00)	=0.001
≥70 years	24.54 (5.67)	24.26 (5.55)	−0.71 (−0.29 to –1.37)	=0.001

Table 3 Patient characteristics at admission according to NRS®-2002 score

	NRS®-2002	Mean	95 % CI for the mean	Difference of means	95 % CI for the difference*
Age, years	< 3	62.25	(60.62; 63.87)	+6.87	(+4.05; +9.70)
	≥ 3	69.12	(66.73; 71.50)		
Weight, kg	< 3	70.89	(69.05; 72.74)	−11.81	(−14.95; −8.67)
	≥ 3	59.08	(56.54; 61.62)		
BMI, kg/m^2	< 3	25.93	(25.27; 26.59)	−3.64	(−4.78; −2.48)
	≥ 3	22.30	(21.31; 23.28)		
Arm circumference, cm	< 3	28.91	(28.41; 29.41)	−2.46	(−1.61; −1.26)
	≥ 3	26.45	(25.75; 27.15)		
Calf circumference, cm	< 3	35.68	(34.95; 36.41)	−2.46	(−3.67; −1.26)
	≥ 3	33.22	(32.31; 34.12)		
Serum albumin level, g/dl	< 3	3.64	(3.54; 3.74)	−0.46	(−0.65; −0.27)
	≥ 3	3.18	(3.02; 3.34)		

*95 % confidence interval assuming equality of variances ($p > 0.05$ in Levene's test) for the difference of means in all cases except serum albumin level ($p < 0.05$ in Levene's test)

Discussion

In Spain, the prevalence of HM has been evaluated by the NRS®-2002 tool in four studies [25, 27–29]. The prevalence results obtained in these studies ranged from 24 % [25] to 62 % [28]. In the PREDyCES® study [25], the diagnosis of malignant neoplasms was identified as a risk factor for the development of malnutrition (OR 2.89 [2.14–3.90]; $p < 0.001$).

This study, conceived as a substudy of the PREDyCES® study, is the first to evaluate the risk of malnutrition in oncology patients in Spain by the NRS®-2002 tool. It is also the first to evaluate the prevalence of nutritional risk and the clinical and economic effects of malnutrition in oncology patients hospitalised in Spain.

This study shows that hospitalised oncology patients, especially older oncology patients, are at a high risk of malnutrition. Specifically, more than 30 % of oncology patients, and more than 40 % of oncology patients who were ≥70 years old were at risk of malnutrition at admission.

Note that approximately half of the patients admitted to oncology and haematology departments were at risk of malnutrition at admission, showing that the risk of malnutrition is prevalent in both patients with solid tumours and patients with haematological neoplasms.

In patients aged ≥70 years, the prevalence of nutritional risk at admission to respiratory, neurology, oncology and haematology departments was 100 % or close to 100 %, meaning that virtually all elderly oncology patients admitted to these departments are at risk of malnutrition.

Our results are consistent with those in studies that evaluated the prevalence of nutritional risk in oncology patients using the NRS®-2002 in Turkey [30], Italy [31] and Romania [32], which also detected prevalences close to 30 %. However, the prevalence detected in our study is lower than that found in other studies conducted in Mexico [33], the Czech Republic [34] and Norway [35]. One possible explanation lies in the existence of differences in the baseline characteristics of the populations, including differences in the distribution by sex and age or in tumour location and stage.

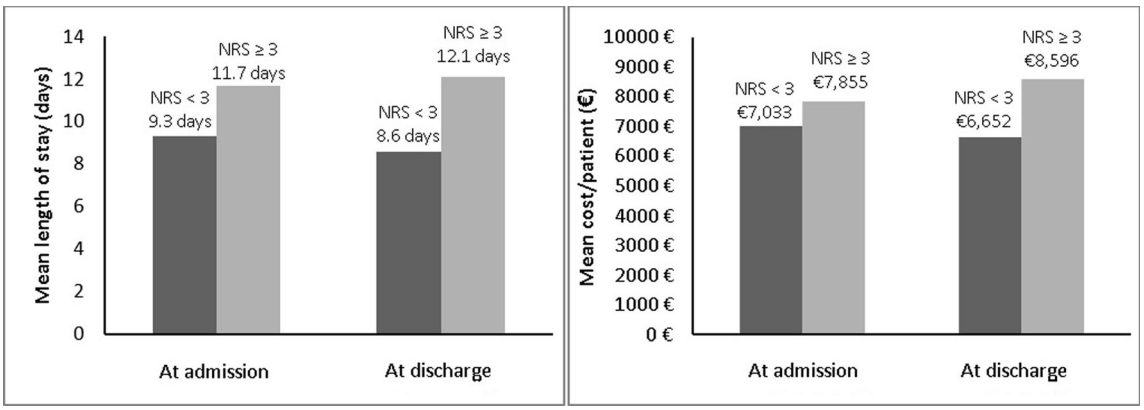

Fig. 1 Mean duration of hospital stay and healthcare costs in oncology patients at nutritional risk (NRS®-2002 ≥ 3) and not at risk (NRS®-2002 < 3) at admission and discharge

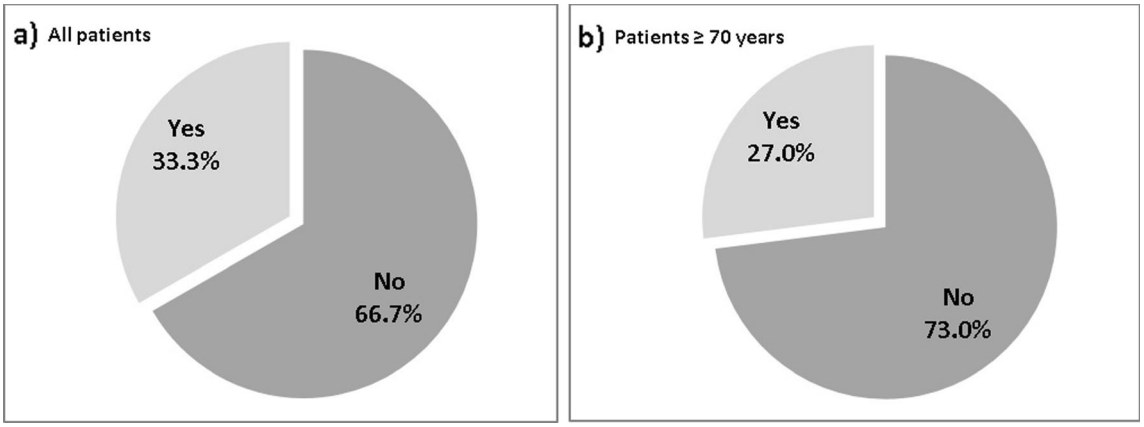

Fig. 2 Nutritional support during hospitalisation in oncology patients at nutritional risk (NRS®-2002 ≥ 3) at discharge

The increased prevalence of risk of malnutrition together with the reduction in mean body weight and BMI, together with the gradual weight loss during hospitalisation suggests that the nutritional status of oncology patients worsens during hospitalisation. In fact, in elderly patients, the prevalence of nutritional risk at discharge was 12 % higher than at admission (50 vs. 38 %).

The tendency for nutritional status to decline during hospitalisation was particularly significant in patients with haematological neoplasms, in which the prevalence of nutritional risk was of 36.8 % at admission and 51.6 % at discharge, and in patients with tumours of the lower gastrointestinal tract (39.1 % at admission vs. 46.3 % at discharge) and of the upper gastrointestinal tract (47.4 % at admission vs. 50.0 % at discharge).

Despite the importance of nutritional status in the evolution and quality of life of oncology patients [5, 11], and the growing evidence of the efficiency of taking steps to correct hospital malnutrition [36], only a third of the patients who were at nutritional risk at discharge had received some kind of nutritional support during hospitalisation. This contrasts with the recommendations regarding enteral and parenteral nutrition in oncology patients issued by ESPEN [37, 38] and by the Spanish Society for Parenteral and Enteral Nutrition (SENPE), the Spanish Society of Medical Oncology (SEOM) and the Spanish Society of Medical Radiology (SEOR) [39].

Another point to stress is that, although BMI values were lower in patients at risk than in patients not at risk, both groups had BMI values close to normality both at admission and at discharge, supporting the idea that BMI alone is not a sufficient indicator of nutritional status [40, 41].

In our study, the presence of nutritional risk was associated with significantly longer hospitalisation and a significant increase in cost, which is consistent with the results of other studies in which malnutrition was associated with longer hospitalisation, poorer quality of life, greater risk of complications and reduced tolerance and response to treatments [3–6, 42–44].

Implementing strategies to detect malnutrition early in all stages of the disease is essential for taking measures to help to prevent its fatal consequences [13] and improving patients' quality of life [45–47].

The most significant limitation of this study is that it is a subanalysis of a study that included both oncology patients and non-oncology patients, which has implications for both the sample size and the collected variables. On the one hand, the sample size was not calculated in order to estimate the prevalence or relation between nutritional risk and hospital stay in oncology patients; instead, it was determined by the number of patients who participated in the general study. On the other hand, the reduced number of patients with each type of tumour and the lack of information regarding tumour stage limits the conclusions that can be reached from the study. Another limitation is that the cost was calculated based on duration of hospitalisation, without considering incidence or cost of complications. In future studies, it will be interesting to evaluate the prevalence of nutritional risk in a larger number of oncology patients, stratified according to type of tumour to determine incidence of complications, mortality and response to treatments, and to characterise the costs associated with HM in detail. Notwithstanding its limitations, this study provides valuable information regarding the prevalence and burden of malnutrition in a set of oncology patients representative of routine clinical practice in Spain.

In conclusion, this study shows that nutritional risk is a prevalent condition in hospitalised oncology patients. In these patients, nutritional risk is associated with extended hospitalisation and increased healthcare costs. The results of this study also suggest that the nutritional status of oncology patients worsens during hospitalisation.

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Compliance with ethical standards Funding

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Conflict of interest

The authors declare that the funding provider was not involved in analysing the results and preparing the conclusions of this study, and that no conflict of interest exists with the aforementioned organisations.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

References

1. Norman K, Pichard C, Lochs H, Pirlich M (2008) Prognostic impact of disease-related malnutrition. Clin Nutr 27(1):5–15
2. Correia MI, Hegazi RA, Higashiguchi T, Michel JP, Reddy BR, Tappenden KA, Uyar M, Muscaritoli M (2014) Evidence-based recommendations for addressing malnutrition in health care: an updated strategy from the feedM.E. Global Study Group. J Am Med Dir Assoc 15(8):544–550
3. Kwag SJ, Kim JG, Kang WK, Lee JK, Oh ST (2014) The nutritional risk is an independent factor for postoperative morbidity in surgery for colorectal cancer. Ann Surg Treat Res 86(4):206–211
4. Yu K, Zhou XR, He SL (2013) A multicentre study to implement nutritional risk screening and evaluate clinical outcome and quality of life in patients with cancer. Eur J Clin Nutr 67(7):732–737
5. Vashi PG, Gupta D, Lammersfeld CA, Braun DP, Popiel B, Misra S, Brown KC (2013) The relationship between baseline nutritional status with subsequent parenteral nutrition and clinical outcomes in cancer patients undergoing hyperthermic intraperitoneal chemotherapy. Nutr J 12:118
6. Nitenberg G, Raynard B (2000) Nutritional support of the cancer patient: issues and dilemmas. Crit Rev Oncol Hematol 34(3):137–168
7. Fiorelli A, Vicidomini G, Mazzella A, Messina G, Milione R, Di Crescenzo VG, Santini M (2014) The influence of body mass index and weight loss on outcome of elderly patients undergoing lung cancer resection. Thorac Cardiovasc Surg 62(7):578–587
8. Rey-Ferro M, Castaño R, Orozco O, Serna A, Moreno A (1997) Nutritional and immunologic evaluation of patients with gastric cancer before and after surgery. Nutrition 13(10):878–881
9. Gupta D, Lis CG, Granick J, Grutsch JF, Vashi PG, Lammersfeld CA (2006) Malnutrition was associated with poor quality of life in colorectal cancer: a retrospective analysis. J Clin Epidemiol 59(7):704–709
10. Jager-Wittenaar H, Dijkstra PU, Vissink A, van der Laan BF, van Oort RP, Roodenburg JL (2011) Malnutrition and quality of life in patients treated for oral or oropharyngeal cancer. Head Neck 33(4):490–496
11. Lis CG, Gupta D, Lammersfeld CA, Markman M, Vashi PG (2012) Role of nutritional status in predicting quality of life outcomes in cancer—a systematic review of the epidemiological literature. Nutr J 11:27
12. Ma L, Wu T, Pan J, Kong X, Guo Q, Yang L, Zhang Y, Lin S, Chen C, Huang C (2014) The correlation between the comprehensive nutrition index and quality of life of patients with nasopharyngeal carcinoma treated by intensity-modulated radiotherapy. Nutr Cancer 66(1):152–158
13. Van Cutsem E, Arends J (2005) The causes and consequences of cancer-associated malnutrition. Eur J Oncol Nurs 9(Suppl 2):S51–S63
14. Nicolini A, Ferrari P, Masoni MC, Fini M, Pagani S, Giampietro O, Carpi A (2013) Malnutrition, anorexia and cachexia in cancer patients: a mini-review on pathogenesis and treatment. Biomed Pharmacother 67(8):807–817
15. Von Haehling S, Anker SD (2010) Cachexia as a major underestimated and unmet medical need: facts and numbers. J Cachex Sarcopenia Muscle 1(1):1–5
16. Tong H, Isenring E, Yates P (2009) The prevalence of nutrition impact symptoms and their relationship to quality of life and clinical outcomes in medical oncology patients. Support Care Cancer 17(1):83–90
17. Olsson U, Bosaeus I, Svedlund J, Bergbom I (2007) Patients' subjective symptoms, quality of life and intake of food during the recovery period 3 and 12 months after upper gastrointestinal surgery. Eur J Cancer Care (Engl) 16(1):74–85
18. Russi EG, Raber-Durlacher JE, Sonis ST (2014) Local and systemic pathogenesis and consequences of regimen-induced inflammatory responses in patients with head and neck cancer receiving chemoradiation. Mediat Inflamm 2014:518261
19. Silver HJ, Dietrich MS, Murphy BA (2007) Changes in body mass, energy balance, physical function, and inflammatory state in patients with locally advanced head and neck cancer treated with concurrent chemoradiation after low-dose induction chemotherapy. Head Neck 29(10):893–900
20. Baldwin C, McGough C, Spiro A, Thomas K, Cunningham DC, Andreyev HJN (2009) Nutritional and clinical characteristics of patients with gastrointestinal tract (GI) cancers at presentation. Proceedings of the Nutrition Society 68(OCE1)
21. Andreyev HJ, Norman AR, Oates J, Cunningham D (1998) Why do patients with weight loss have a worse outcome when undergoing chemotherapy for gastrointestinal malignancies? Eur J Cancer 34(4):503–509
22. Dewys WD, Begg C, Lavin PT, Band PR, Bennett JM, Bertino JR, Cohen MH, Douglass Jr HO, Engstrom PF, Ezdinli EZ, Horton J, Johnson GJ, Moertel CG, Oken MM, Perlia C, Rosenbaum C, Silverstein MN, Skeel RT, Sponzo RW, Tormey DC (1980) Prognostic effect of weight loss prior to chemotherapy in cancer patients. Eastern Cooperative Oncology Group. Am J Med 69(4):491–497
23. Segura A, Pardo J, Jara C, Zugazabeitia L, Carulla J, de Las PR, García-Cabrera E, Luz Azuara M, Casadó J, Gómez-Candela C (2005) An epidemiological evaluation of the prevalence of malnutrition in Spanish patients with locally advanced or metastatic cancer. Clin Nutr 24(5):801–814
24. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M (2003) Educational and Clinical Practice Committee, European Society of Parenteral and Enteral Nutrition (ESPEN). ESPEN guidelines for nutrition screening 2002. Clin Nutr 22(4):415–421
25. Álvarez-Hernández J, Planas Vila M, León-Sanz M, García de Lorenzo A, Celaya-Pérez S, García-Lorda P, Araujo K, Sarto Guerri B (2012) PREDyCES researchers. Prevalence and costs of malnutrition in hospitalized patients; the PREDyCES study. Nutr Hosp 27(4):1049–1059

26. Planas Vila M, Álvarez Hernández J, García de Lorenzo A, Celaya Pérez S, León Sanz M, García-Lorda P, Brosa M (2010) The burden of hospital malnutrition in Spain: methods and development of the PREDyCES® study. Nutr Hosp 25(6):1020–1024
27. Olivares J, Ayala L, Salas-Salvadó J, Muñiz MJ, Gamundí A, Martínez-Indart L, Masmiquel LL (2014) Assessment of risk factors and test performance on malnutrition prevalence at admission using four different screening tools. Nutr Hosp 29(3):674–680
28. Mercadal-Orfila G, Lluch-Taltavull J, Campillo-Artero C, Torrent-Quetglas M (2012) Association between nutritional risk based on the NRS-2002 test and hospital morbidity and mortality. Nutr Hosp 27(4):1248–1254
29. Velasco C, García E, Rodríguez V, Frias L, Garriga R, Alvarez J, García-Peris P, León M (2011) Comparison of four nutritional screening tools to detect nutritional risk in hospitalized patients: a multicentre study. Eur J Clin Nutr 65(2):269–274
30. Gur AS, Atahan K, Aladag I, Durak E, Cokmez A, Tarcan E, Tavusbay C (2009) The efficacy of Nutrition Risk Screening-2002 (NRS-2002) to decide on the nutritional support in general surgery patients. Bratisl Lek Listy 110(5):290–292
31. Bozzetti F, Mariani L, Lo Vullo S, SCRINIO Working Group, Amerio ML, Biffi R, Caccialanza G, Capuano G, Correja I, Cozzaglio L, Di Leo A, Di Cosmo L, Finocchiaro C, Gavazzi C, Giannoni A, Magnanini P, Mantovani G, Pellegrini M, Rovera L, Sandri G, Tinivella M, Vigevani E (2012) The nutritional risk in oncology: a study of 1,453 cancer outpatients. Support Care Cancer 20(8):1919–1928
32. Gheorghe C, Pascu O, Iacob R, Vadan R, Iacob S, Goldis A, Tantau M, Dumitru E, Dobru D, Miutescu E, Saftoiu A, Fraticiu A, Tomescu D, Gheorghe L (2013) Nutritional risk screening and prevalence of malnutrition on admission to gastroenterology departments: a multicentric study. Chirurgia (Bucur) 108(4):535–541
33. Alvarez-Altamirano K, Delgadillo T, García-García A, Alatriste-Ortiz G, Fuchs-Tarlovsky V (2014) Prevalence of nutritional risk evaluated with nrs-2002 in Mexican oncology population. Nutr Hosp 30(1):173–178
34. Illa P, Tomíšková M, Skřičková J (2014) Screening of malnutrition risk versus indicators of nutritional status and systemic inflammatory response in newly diagnosed lung cancer patients]. Klin Onkol 27(4):261–268
35. Tangvik RJ, Tell GS, Guttormsen AB, Eisman JA, Henriksen A, Nilsen RM, Ranhoff AH (2014) Nutritional risk profile in a university hospital population. Clin Nutr S0261-5614(14)00205-00202. doi:10.1016/j.clnu.2014.08.001
36. Freijer K, Bours MJ, Nuijten MJ, Poley MJ, Meijers JM, Halfens RJ, Schols JM (2014) The economic value of enteral medical nutrition in the management of disease-related malnutrition: a systematic review. J Am Med Dir Assoc 15(1):17–29
37. Arends J, Bodoky G, Bozzetti F, Fearon K, Muscaritoli M, Selga G, van Bokhorst-de van der Schueren MA, von Meyenfeldt M, DGEM (German Society for Nutritional Medicine), Zürcher G, Fietkau R, Aulbert E, Frick B, Holm M, Kneba M, Mestrom HJ, Zander A (2006) ESPEN (European Society for Parenteral and Enteral Nutrition). ESPEN guidelines on enteral nutrition: non-surgical oncology. Clin Nutr 25(2):245–259
38. Bozzetti F, Arends J, Lundholm K, Micklewright A, Zurcher G, Muscaritoli M, ESPEN (2009) ESPEN guidelines on parenteral nutrition: non-surgical oncology. Clin Nutr 28(4):445–454
39. Bosch R, García A, Mañas A (2008) Guía clínica multidisciplinar sobre el manejo de la nutrición en el paciente con cáncer. http://www.oncologiaynutricion.com/archivos/pubs/libroconsenso.pdf. Accessed: 18 Mar 2015
40. Platek ME, Popp JV, Possinger CS, Denysschen CA, Horvath P, Brown JK (2011) Comparison of the prevalence of malnutrition diagnosis in head and neck, gastrointestinal, and lung cancer patients by 3 classification methods. Cancer Nurs 34(5):410–416
41. Pressoir M, Desné S, Berchery D, Rossignol G, Poiree B, Meslier M, Traversier S, Vittot M, Simon M, Gekiere JP, Meuric J, Serot F, Falewee MN, Rodrigues I, Senesse P, Vasson MP, Chelle F, Maget B, Antoun S, Bachmann P (2010) Prevalence, risk factors and clinical implications of malnutrition in French Comprehensive Cancer Centres. Br J Cancer 102(6):966–971
42. Amaral TF, Antunes A, Cabral S, Alves P, Kent-Smith L (2008) An evaluation of three nutritional screening tools in a Portuguese oncology centre. J Hum Nutr Diet 21(6):575–583
43. Gavazzi C, Colatruglio S, Sironi A, Mazzaferro V, Miceli R (2011) Importance of early nutritional screening in patients with gastric cancer. Br J Nutr 106(12):1773–1778
44. Takahashi H, Chiba T, Tairabune T, Kimura Y, Wakabayashi G, Takahashi K, Kudo K (2014) A retrospective study on the influence of nutritional status on pain management in cancer patients using the transdermal fentanyl patch. Biol Pharm Bull 37(5):853–857
45. Isenring EA, Capra S, Bauer JD (2004) Nutrition intervention is beneficial in oncology outpatients receiving radiotherapy to the gastrointestinal or head and neck area. Br J Cancer 91(3):447–452
46. Moreland SS (2012) Nutrition screening and counseling in patients with lung cancer in an outpatient setting. J Adv Pract Oncol 3(3): 191–193
47. Tan CR, Yaffee PM, Jamil LH, Lo SK, Nissen N, Pandol SJ, Tuli R, Hendifar AE (2014) Pancreatic cancer cachexia: a review of mechanisms and therapeutics. Front Physiol 5:88