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How does the choice of the nutritional screening tool and malnutrition diagnosis influence hospital reimbursement?

De que forma a escolha da ferramenta de rastreio nutricional e o diagnóstico de desnutrição influenciam o financiamento hospitalar?

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Abstract

Introduction: This cross-sectional study aimed to determine how the choice of nutritional screening tool and malnutrition diagnosis influences the potential hospital reimbursement for patients admitted to an internal medicine ward.

Methods: A consecutive sampling from all admitted patients in the internal medicine ward was collected. Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) and Nutritional Risk Screening 2002 (NRS 2002) were used to screen for malnutrition, and PG-SGA was used to assess for malnutrition in all participants. For each malnourished patient, medical coders performed two simulations of the calculus of Diagnosis-Related Group (DRG) code, Severity of Illness (SOI), and Risk of Mortality (ROM) levels with and without malnutrition diagnosis, to obtain Relative Weight (RW) and Hospital Costs (HC). Differences in RW and HC were calculated and extrapolated to obtain the unclaimed potential hospital reimbursement.

Results: Of the 132 included patients, 69.7% were malnourished. From the subsample of 71 coded patients, 89% were at risk according to PG-SGA SF, of these, 75% were malnourished. Based on NRS 2002, 75% of patients were at risk, of which 83% were malnourished. With the inclusion of malnutrition diagnosis in the coding of malnourished patients, HC increased € 31K and € 26K for patients identified as at risk by PG-SGA SF and NRS 2002, respectively. After extrapolation for the annual HC, these could reach € 1.2M.

Conclusion: Regardless of the nutritional screening tool used, the inclusion of malnutrition diagnosis in medical records increases HC, with the potential to improve hospital reimbursement.

Resumo

Introdução: Pretendeu-se determinar de que forma a escolha da ferramenta de rastreio nutricional e o diagnóstico de desnutrição podem influenciar o potencial financiamento hospitalar em doentes internados num serviço de medicina.

Métodos: Neste estudo transversal, após uma amostragem consecutiva, foram avaliados doentes internados num serviço de medicina; o rastreio de desnutrição foi feito aplicando o *Patient-Generated Global Assessment Short Form* (PG-SGA SF) e o *Nutritional Risk Screening 2002* (NRS 2002), e a avaliação da desnutrição foi feita aplicando o PG-SGA. Para cada doente desnutrido, foi solicitado aos médicos codificadores o código de Grupos de Diagnóstico Homogéneos e os níveis de Severidade da Doença e de Risco de Mortalidade com e sem diagnóstico de desnutrição, de modo a obter as diferenças no Peso Relativo (PR) e no Custo Hospitalar (CH) de cada doente. Extrapolou-se o CH anual, para obter o potencial financiamento hospitalar não reclamado.

Resultados: Dos 132 doentes incluídos, 69,7% estavam desnutridos. Da subamostra dos 71 doentes codificados, 89% encontravam-se em risco pelo PG-SGA SF; destes, 75% estavam desnutridos. Usando o NRS 2002, 75% dos doentes encontrava-se em risco de desnutrição e destes 83% estavam desnutridos. Quando incluído o diagnóstico de desnutrição nestes doentes, o CH aumentou 31.000€ e 26.000€ respetivamente nos doentes em risco identificados pelo PG-SGA SF e pelo NRS 2002. Extrapolando estes resultados para o CH anual, este pode chegar aos 1,2 milhões €.

Conclusão: Independentemente da ferramenta de rastreio nutricional adotada, a inclusão do diagnóstico de desnutrição nos registos médicos aumenta o CH, com potencial para melhorar o financiamento hospitalar.

Keywords

Malnutrition, NRS 2002, PG-SGA, Hospital Reimbursement, Diagnosis Related Groups

Palavras-chave

Desnutrição, NRS 2002, PG-SGA, Financiamento Hospitalar, Grupos de Diagnóstico Homogéneos

Abbreviations and Acronyms

ANUMEDI – Nutritional Evaluation in Internal Medicine

APNEP – Associação Portuguesa de Nutrição Entérica e Parentérica

APR-DGR – All Patients Refined Diagnosis-Related Group

ASPEN – American Society for Parenteral and Enteral Nutrition

BMI – Body Mass Index

CHMA, EPE – Centro Hospitalar do Médio Ave, Entidade Pública Empresarial

CMI – Case Mix Index

DRG – Diagnosis-Related Group

ESPEN – European Society for Clinical Nutrition and Metabolism

GENT – Grupo de Estudos de Nutrição para Todos

HC – Hospitalization Costs

ICD-10-CM/PCS - International Classification of Diseases 10th revision, Clinical Modification/Procedure Coding System

IQR – Interquartile Range

LOS – Length of Stay

MUAC – Mid Upper Arm Circumference

NRS 2002 – Nutrition Risk Screening 2002

PG-SGA – Patient-Generated Subjective Global Assessment

PG-SGA SF - Patient-Generated Subjective Global Assessment Short Form

ROM – Risk of Mortality

RW – Relative Weight

SD – Standard Deviation

SOI – Severity of Illness

Content

Introduction

Malnutrition is common among hospitalized patients. This high prevalence of malnutrition has been described for more than 40 years[1]. However, it still affects 20-50% of the hospitalized patients[2, 3] depending on the definition of malnutrition, the patient population, and setting analyzed. In Portugal, a cross-sectional study that used the Nutritional Risk Screening 2002 (NRS 2002) and anthropometric measures for malnutrition assessment in 6 hospitals, revealed that 28.5% to 47.3% of the inpatients were at risk of malnutrition and 6.3% to 14.9% were malnourished[4]. More recently, a study with data from NutritionDay in 2015, showed that 46% of hospitalized patients in Portugal were at nutritional risk[5]. Specifically, for the Portuguese internal medicine ward population, a recent multicenter study in 24 Portuguese hospitals showed that 72.8% of patients were malnourished[6].

Guidelines from the European Society for Clinical Nutrition and Metabolism (ESPEN) consider “malnutrition”, defining it as “a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat-free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease”[7]. This state can be disease-related with or without inflammation, or it can result from starvation, which is more common in poor developing countries. Advanced ageing can also contribute to any form of malnutrition[7].

Malnutrition has negative effects on the patient. This condition deteriorates physical well-being and quality of life and contributes to adverse clinical outcomes, such as an increased risk of complications, infections, poor wound healing, longer

length of stay (LOS), increased readmission rates and hospital costs, worsened functional status at discharge, and higher morbidity and mortality rates[8-15].

Recognition and identification of malnutrition, including its severity, is essential to start timely intervention and avoid its consequences. Therefore, various, simple, fast, low-cost and validated nutrition screening and assessment tools have been developed to identify patients at risk of malnutrition and to triage for interventions[13, 16, 17]. ESPEN suggests the use of NRS 2002, a validated nutrition screening tool for the hospital setting[7, 16, 18]. However, the Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) has shown better diagnostic accuracy than NRS 2002, i.e. better sensitivity and specificity, using the full PG-SGA as reference[19]. The PG-SGA SF is the patient component of the full PG-SGA and has been validated as a screening tool to screen for malnutrition and its risk factors[20, 21]. The PG-SGA SF comprises all domains of malnutrition defined by ESPEN and by The American Society for Parenteral and Enteral Nutrition (ASPEN)[21] but it also includes more risk factors for malnutrition than other screening tools, which makes the PG-SGA SF more sensitive[22]. ESPEN finds PG-SGA appropriate for nutritional assessment[7], which has been defined as a more detailed evaluation to diagnose and classify the severity of malnutrition[13].

The use of screening and assessment tools allows malnourished patients to be recognized, diagnosed, and treated[9, 11-13]. These three components are essential, not only to improve the interdisciplinary clinical approach and overall patient outcomes, but also to provide clearer documentation of the patient's malnutrition diagnosis in the medical record. Since malnutrition can influence a patient's length of stay, readmission rates and treatments, the presence of malnutrition diagnosis

in the medical record is necessary for the correct calculation of hospitalization costs (HC) and for hospitals to obtain the appropriate reimbursement[2, 11-13, 23-25].

There are many types of hospital reimbursement systems[26, 27]. In Portugal, this is based on the All Patients Refined Diagnosis-Related Group (APR-DRG)[28, 29]. The APR-DRG represents a classification system of acute illness that is treated during hospitalization, allowing the operational characterization of the hospital production. According to this system, patients are grouped into a specific Diagnosis-Related Group (DRG) upon discharge, based on age, sex, discharge destination, principal and secondary diagnoses and clinical procedures coded with the International Classification of Diseases 10th revision Clinical Modification/Procedure Coding System (ICD-10-CM/PCS)[28, 29]. With these data and using coding software by certified medical coders, the DRG code, the severity of illness (SOI), and risk of mortality (ROM) are obtained for each patient. SOI relates to “the extent of physiologic decompensation or organ system loss of function”, while ROM relates to “the likelihood of dying”[30].

Four subclass values are given to each SOI and ROM, ranging from 1 to 4, representing, respectively, minor, moderate, major or extreme SOI and ROM. SOI and ROM are highly correlated; however, given that they relate to distinct patient attributes (i.e., associated organ system dysfunction and the associated likelihood of dying), they often differ for many diagnoses[31]. The DRG in conjunction with ROM is applied to evaluate patient mortality, while the DRG in conjunction with SOI is used to evaluate resource use[30].

The relative weight (RW) is obtained from the DRG code and the SOI level and it is a ponderation coefficient that reflects the expected HC of a standard patient, expressed in relative terms according to the baseline price of the average national

patient[28, 29]. The higher the SOI, the higher the RW and, consequently, the higher the HC[29].

The Case Mix Index (CMI) is a global ponderation coefficient that compares one hospital to another, in terms of the complexity of its casuistry. It is defined as “the number of similar patients from each DRG code, pondered by their RWs and the total number of similar patients from the hospital”. The national CMI is 1, so the CMI from each health unit will deviate from this reference value according to the proportion of patients grouped in DRG with higher RW compared to the national standard[28].

Malnutrition is often considered a secondary diagnosis, since it coexists with the principal diagnosis which is the underlying cause for the patient’s admission[32]. With coexistence of multiple serious conditions, ROM and SOI values may increase[31], resulting in increasing RW and HC. The HC, adjusted for the CMI, represents the hospital reimbursement. A recent monograph in the United States showed that the diagnosis of severe malnutrition is frequently missing when the DRG code is obtained by the medical coders. This leads to an underrepresentation of the hospital’s actual ROM and SOI level[11] and, consequently, decreases its reimbursement.

In clinical practice, the choice of the screening tool may influence the number of patients diagnosed with malnutrition. More sensitive tools are likely to result in more patients undergoing full nutritional assessment, and may result in more patients being diagnosed as malnourished[19, 21, 33]. Therefore, in this study, malnutrition risk and nutritional status assessment was performed at Centro Hospitalar do Médio Ave, Entidade Pública Empresarial (CHMA, E.P.E.), using NRS 2002, PG-SGA SF and PG-SGA, in order to understand how the choice of

the nutritional screening tool may influence the potential hospital reimbursement for patients categorized as malnourished by PG-SGA.

Aim of the study

To determine how the choice of nutritional screening tool and malnutrition diagnosis may influence the potential hospital reimbursement for patients admitted to an internal medicine ward.

Research questions:

- How frequent is nutritional risk and malnutrition in patients admitted to the internal medicine ward of CHMA, EPE?
- How does the inclusion of malnutrition diagnosis in the clinical records change SOI and ROM levels according to APR-DRG system and the HC at the internal medicine ward?
- How does malnutrition screening using PG-SGA SF and NRS 2002 influence the SOI and ROM level and the HC at the internal medicine ward?

Methods

A cross-sectional study was conducted at the internal medicine ward of CHMA, EPE, between April 24 and May 22, 2018. CHMA, EPE is a 2 unit regional hospital, located at Vila Nova de Famalicão and Santo Tirso, with a total of 101 internal medicine beds. A consecutive sampling approach was used, allowing the inclusion of patients admitted in the previous 72 hours from the daily list of patients admitted to the internal medicine ward.

Patients under isolation precautions and patients who were discharged before being approached were not considered eligible for inclusion in the study. Each

eligible patient was informed about the study procedures, after which they (or their relative/legal representative) were asked to give their written informed consent.

Nutritional screening and assessment

To screen for malnutrition, PG-SGA SF was completed by the patient, if capable; if not, PG-SGA SF was completed by the researcher according to information provided by the patient or its caregiver. The PG-SGA SF consists of four boxes: Box 1 assesses the patient's weight change, Box 2 evaluates the change in food intake, Box 3 refers to the presence of nutrition impact symptoms, and Box 4 evaluates activities and functioning[21]. Patients with PG-SGA SF total score ≥4 were considered to be nutritionally at risk[33].

The researcher completed the NRS 2002 for every participant. The NRS 2002 classifies patients by 3 items: "Nutritional status" (score of 0-3) defined by recent reduction in food intake, weight loss, and body mass index (BMI); "Severity of disease" (score of 0-3) classified as absent, mild, moderate or severe; and adds an extra point for patients older than 70 years. Patients with a total NRS 2002 score ≥3 were considered to be nutritionally at risk[16, 18].

To apply the screening tools, anthropometric measurements (weight or mid upper arm circumference [MUAC]) were performed according to the techniques of the International Standards of Anthropometric Assessment[34]. Patients who could stand on their feet were weighed wearing light clothes with a scale (SECA, model 761). For patients who were not able to stand on a scale, the self-reported weight on admission was used. Due to the lack of a stadiometer, height was self-reported or retrieved from the national identification card. As suggested by ESPEN, when body weight could not be measured, nor reported, or if it was unreliable due to accumulation of fluid, MUAC was used[18]. Therefore, a MUAC <25 cm was

considered equivalent to a BMI <20.5 kg/m^2[18]. In patients whose right arm was injured or had peripheral vascular accesses, MUAC was measured on the left arm. PG-SGA was used for the diagnosis of malnutrition, in all participants[35, 36]. PG-SGA has demonstrated good validity to assess malnutrition and its risk factors in both cancer and non-cancer patient populations internationally [21, 35, 37]. It includes the PG-SGA SF, completed by the patient, followed by five Worksheets completed by the interviewer. Worksheet 1 refers to the scoring of weight loss; Worksheet 2 addresses conditions that may increase nutritional requirements; Worksheet 3 refers to metabolic stress, e.g., fever and corticosteroids; Worksheet 4 includes the physical examination (scoring muscle status, fat stores, and the presence of edema and ascites), and Worksheet 5 provides a global rating from the findings in PG-SGA SF plus the physical examination from Worksheet 4. Based on Worksheet 5, patients were divided into three categories: well nourished (PG-SGA A), moderate/suspected malnutrition (PG-SGA B), or severely malnourished (PG-SGA C)[21, 35].

Baseline data from the electronic patient file were extracted to complete the screening and assessment tools: sex, age, diseases, stage of disease, type and dose of medication prescribed, symptoms and problems associated with food intake or nutritional status, if the patient could not complete the PG-SGA SF.

Determination of DRG code, SOI, ROM, RW and HC

From all screened patients, the ones still admitted by the end of the study were excluded.

To study how malnutrition impacts SOI and ROM levels, RW and HC for the patients diagnosed with malnutrition, the medical coders performed two simulations of the calculus of DRG code, SOI and ROM levels for each

malnourished patient from the subsample: one including the malnutrition diagnosis, and the other not including the malnutrition diagnosis.

The codes from ICD-10-CM/PCS used for malnutrition diagnosis were the E46 for the category “PG-SGA B” and the E43 for the category “PG-SGA C”[9].

The RW and HC for the malnourished patients were obtained from Portuguese Ministerial Directive number 207/2017, according to the DRG and SOI values [29].

The difference between the RW and the HC with and without the malnutrition diagnosis was calculated.

Additionally, the number of patients who were admitted to the internal medicine ward during the previous year was obtained. This was used to calculate the unclaimed potential reimbursement for this hospital (per annum), by extrapolating the difference in the totality of HC from this subsample to the number of patients in one year.

The medical records from all coded patients were accessed to register their LOS, to check for admissions during the previous year, and to register referral to the clinical nutritionist at the nutrition department.

Ethical approval

The study was approved by the Ethics Committee of CHMA, E.P.E. on April 20th, 2018 (Registration number: SGIS/08/2018), and was performed according to the Helsinki declaration[38].

Statistical analysis

Data were analyzed using *IBM® SPSS™ Statistics* version 25.0, for *Windows*, and results were considered significant when $P<0.05$. Skewness, kurtosis and Kolmogorov-Smirnov were used to evaluate normality of data. Descriptive analyses were conducted for the sociodemographic and nutritional status

characterization of the study sample. Categorical variables were reported as frequencies and continuous variables were expressed as mean ± standard deviation (SD) or median and interquartile range (IQR). Differences between well nourished and malnourished patients were compared using Chi-square statistics for sex and number of patients with readmissions during the previous year and Fishers exact test was used to compare the number of patients referred to the clinical nutritionist. Student t-test for independent samples was used to test for differences for normally distributed data (age). Non-normally distributed data (LOS) were compared using Mann-Whitney test. Finally, Wilcoxon test was used to test for differences in ROM and in SOI levels with and without malnutrition diagnosis, and to test for differences in total HC between PG-SGA SF and NRS 2002.

Results

1. Nutritional status of the patients

The consecutive sampling approach resulted in 188 potential participants.

Twenty-one patients under isolation precautions and 12 patients who were discharged before being approached were not included, resulting in 155 patients invited to participate. From the invited patients, 23 did not agree on giving written informed consent, resulting in a total of 132 study participants.

The sample of 132 patients, aged 30 to 104 years (mean age 76.3 ± 13.5), were screened and assessed for malnutrition (Appendix A). Most participants were men (56.8%). Patient characteristics are shown in Appendix B. According to PG-SGA SF, 88.6% (n=117) of the participants were screened positively for malnutrition risk (PG-SGA SF ≥4 points). Based on NRS 2002, 72.0% (n=95) of participants were at risk of malnutrition (≥3 points). The total prevalence of malnutrition was 69.7%

(n=92): 47.7% (n=63) had moderate/suspected malnutrition (PG-SGA B) and 22.0% (n=29) were severely malnourished (PG-SGA C).

2. Determination of DRG code, SOI and ROM level, RW and HC

Appendix C shows the flowchart for the determination of the impact of malnutrition diagnosis on the values of SOI, ROM, RW and HC according to the APR-DRG system. From the previous sample of 132 patients, the ones still admitted by the end of data collection (n=23) were excluded. Due to availability constrains, medical coders could only analyze participants recruited from April 24 to May 15, and therefore 48 patients had to be excluded. As result, the analysis on SOI, ROM, RW and HC was performed in a subsample of 71 participants.

Characteristics of this subsample are presented in Appendix D. These patients had between 30 and 104 years old (mean age 74.9 ± 13.8) and most were male (53.5%). Median LOS of the coded patients was 8 days (IQR = 6-11). Nineteen patients (25.6%) had been admitted at least one time during the previous year. Clinical nutritionist referral was requested in 4 of the 71 coded patients (5.6%). No statistically significant differences were found in sociodemographic characteristics, LOS, readmissions, and the frequency of clinical nutritionist referral between well nourished and malnourished patients.

Nutritional risk and nutritional status of the 71 coded patients is presented in Appendix E. According to PG-SGA SF, 88.7% (n=63) of coded patients were screened positively for malnutrition risk (PG-SGA SF ≥4 points). According to NRS 2002, 74.6% (n=53) of coded patients were screened positively for malnutrition risk (NRS 2002 ≥3 points).

Of the 63 patients at risk based on PG-SGA SF, 47 were further diagnosed as malnourished. Of the 53 patients at risk based on NRS 2002, 44 were further diagnosed as malnourished.

The effect of the inclusion of malnutrition diagnosis in the ROM level is shown in Appendices F and G. Ten of the malnourished patients, independently from the screening tool used before, had ROM level increased after the inclusion of malnutrition diagnosis. This difference was statistically significant (*P*=0.002).

Nineteen of the malnourished patients identified as at risk from PG-SGA SF had SOI level increased after the inclusion of the malnutrition diagnosis (Appendix H). Eighteen of the malnourished patients identified as at risk from NRS 2002 had SOI level increased after the inclusion of the malnutrition diagnosis (Appendix I). This difference in SOI level with and without malnutrition was statistically significant, whether PG-SGA SF (*P*<0.001) or NRS 2002 (*P*<0.001) was used.

In malnourished patients without change in SOI level, the difference in the results of RW and HC with and without the inclusion of malnutrition diagnosis was zero. For patients who had the SOI level increased, the results are shown in Table 1.

Table 1 - Difference in relative weight and hospitalizations costs after the inclusion of malnutrition diagnosis in the malnourished patients with Severity of Illness level increased.

Difference caused when SOI level increased	**Higher SOI level using PG-SGA SF + PG-SGA** (n=19)	**Higher SOI level using NRS 2002 + PG-SGA** (n=18)
In RW per patient *	0.78 (0.30-0.96)	0.73 (0.30-0.90)
In HC per patient *	€ 1 782.30 (687.79-2194.29)	€ 1 657.08 (679.11-2048.62)
In total HC	**€ 30 901.43**	**€ 26 380.79**

* Median (Interquartile range). Abbreviations: NRS 2002 = Nutritional Risk Screening 2002, PG-SGA SF = Patient-Generated Subjective Global Assessment Short Form, SOI = Severity of Illness, RW = Relative Weight, HC = Hospitalization Costs

During 2017, the internal medicine ward from CHMA, EPE, had 3350 hospitalized patients. Therefore, by extrapolating the results presented in Table 1, the total annual HC for the internal medicine ward using PG-SGA SF and NRS 2002 would have been €1 458 025 and €1 244 727 respectively. The HC based on PG-SGA SF was not significantly different (*P*=0.317) from the HC based on NRS 2002.

Discussion

With this study we found that, regardless of the nutritional screening tool used, the inclusion of malnutrition diagnosis can increase ROM and SOI level, therefore increasing HC around € 30 901 and improving the potential hospital reimbursement.

The nutritional screening results show that the prevalence of nutritional risk at hospital admission in an internal medicine ward of a regional Portuguese hospital is high, regardless of which nutritional screening tool is used. Moreover, results from the full nutritional assessment also show a high prevalence of malnutrition.

Our findings of nutritional risk and malnutrition of the study sample are similar to that found in recent studies[6], but higher than found in older studies[4]. This can be explained by the ageing of the population[39], which has been shown as a risk factor of malnutrition [8, 13, 40, 41].

This high prevalence of malnutrition and its risk corroborates the need for a systematic malnutrition screening program. Screening for malnutrition has been highly recommended before[16, 18, 36, 41-44] and it is a required procedure for hospital accreditation[41]. Nutritional screening is already mandatory in countries like the United Kingdom, United States, The Netherlands, and Denmark[41]. In Portugal, an Order of Minister 6634/2018 was recently published in *Diário da República* (Official Journal of Portugal) on July 6 of 2018[3], stating that all hospitalized adult patients

with a LOS longer than 24 hours will have to be screened with NRS 2002 by a multidisciplinary team. However, the implementation of nutritional screening and assessment is considered challenging[23, 41]. Studies have been recognizing insufficient nutrition-related education, time, monetary resources, lack of support from other staff members, or not clearly defined responsibilities among the medical team as the main difficulties to implement screening and assessment tools for malnutrition [23, 45, 46]. Therefore, when implementing a malnutrition program, an education program and communication between several healthcare professionals will be required to overcome possible gaps[47].

Routine screening and assessment for malnutrition is not implemented in CHMA, EPE and, taking into account the number of clinical nutritionist referrals by its physicians, our findings show poor recognition of malnutrition. Thus, malnutrition remains underrecognized, underdiagnosed, and not documented[12, 23]. This compromises not only patients treatment and, consequently, clinical outcomes but also the score of ROM and SOI, increasing the unclaimed potential reimbursement due to the lack of malnutrition diagnosis in the medical records[12, 23, 24, 32].

From the 71 coded patients, 10 of the malnourished patients had an increased ROM level, regardless of the nutritional screening tool used, showing that malnutrition contributes to an increased risk of mortality, a finding in line with other studies[2, 8, 13, 14].

Malnutrition diagnosis also increased SOI level in 40.4% of the malnourished patients detected through patients at risk according to PG-SGA SF and in 40.9% of the malnourished patients detected through patients at risk according to NRS 2002, leading to an increase in HC, a finding in agreement with previous literature[8, 10, 12, 13, 15].

The finding that in the rest of the malnourished patients, ROM or SOI level did not increase, could be explained by the fact that they already were at the maximum ROM or SOI level, or that the inclusion of malnutrition was not sufficient to increase those levels. The underlying mechanism of how the inclusion of a diagnosis affects the ROM and SOI level is complex and beyond the scope of this study.

It is important to emphasize that the more detailed the registry of complications and comorbidities, the more accurate the patients' codification will be, which will better reflect the true level of ROM and SOI[48].

The increase in HC in our study is in line with another Portuguese study done at an oncology hospital with a sample of 47 patients (48.9% malnourished patients assessed with PG-SGA), that also found a significant increase in HC after inclusion of malnutrition diagnosis[49].

Given that the recognition of malnutrition is poor in CHMA, EPE, the increase in HC, when malnutrition diagnosis is included in the patient codification, corresponds to unclaimed potential reimbursements for the hospital. Therefore, this inclusion could mean an annual increase of HC of €1 458 025 when using PG-SGA SF, or 15% less when using NRS 2002 as a screening tool. This difference could be explained by the higher number of patients at risk detected by PG-SGA SF which results in 3 more patients diagnosed as malnourished. This happens because PG-SGA SF detects more patients at risk due to its higher sensitivity when compared to NRS 2002[19]. Considering that hospital reimbursement is dependent of the HC and CMI, the use of any of these tools to identify patients at risk, followed by adequate nutritional assessment, documenting and coding, may increase potential hospital reimbursement.

The results of our study may bring positive implications to our clinical practice, since this potential additional reimbursement could help to compensate the increased costs associated with treating malnourished patients, as well as to employ additional nutritionists to assist with the identification and management of malnourished patients. Additionally, the routine screening, assessment and treatment of malnutrition in an internal medicine ward would likely decrease HC, since malnutrition influences the patient's LOS, readmission rates, treatments, functional status at discharge, and morbidity and mortality rates[8-15].

This study has some limitations worth acknowledging. Firstly, patients under isolation precautions may be frailer and therefore may have more comorbidities and increased probability of being malnourished. Excluding them from our study can underestimate the prevalence of malnutrition and HC. Secondly, not all patients were included in the ROM and SOI level analysis, which could underestimate the results of HC. Thirdly, for the annual extrapolation of the potential unclaimed reimbursement, the seasonality of hospital admission was not considered, which could also under- or overestimate the results of the unclaimed reimbursement per year.

Conclusions

In this study we found that, regardless of nutritional screening tool used, the inclusion of malnutrition diagnosis in the medical records can increase ROM and SOI level, thereby increasing the HC, improving the potential hospital reimbursement and contributing positively to economic sustainability of CHMA, EPE.

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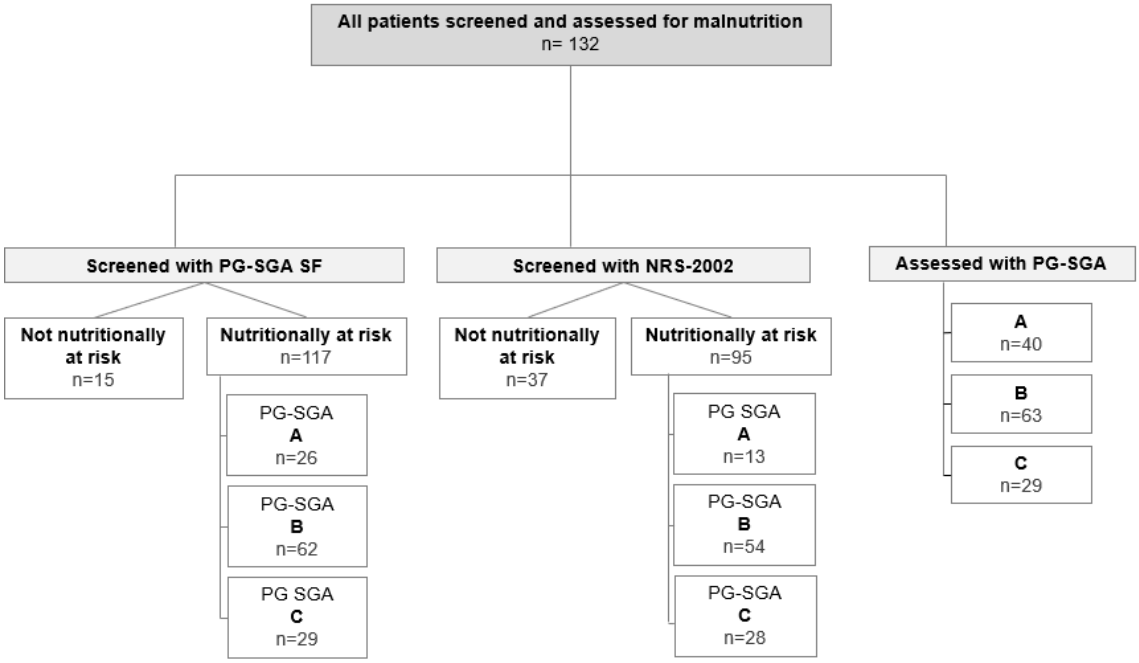
APPENDICES

Appendices

Appendix A – Flowchart of patients admitted in the study and their nutritional status



Abbreviations:

NRS 2002 = Nutritional Risk Screening 2002

PG-SGA = Patient-Generated Subjective Global Assessment

SF = Short Form

PG-SGA A = Well nourished

PG-SGA B = Moderate/Suspected malnutrition

PG-SGA C = Severely malnourished

Appendix B – Descriptive statistics of sociodemographic and nutritional status variables of 132 screened patients

Sex, n (%)	
Male	75 (56.8%)
Female	57 (43.2%)
Age, years *	76.31 ± 13.54
Nutritionally at risk, n (%)	
NRS 2002	95 (72.0%)
PG-SGA Short Form	117 (88.6%)
Assessment for malnutrition, n (%)	
Well nourished	40 (30.3%)
Moderate/suspected malnutrition	63 (47.7%)
Severely malnourished	29 (22.0%)

***** Mean ± Standard deviation

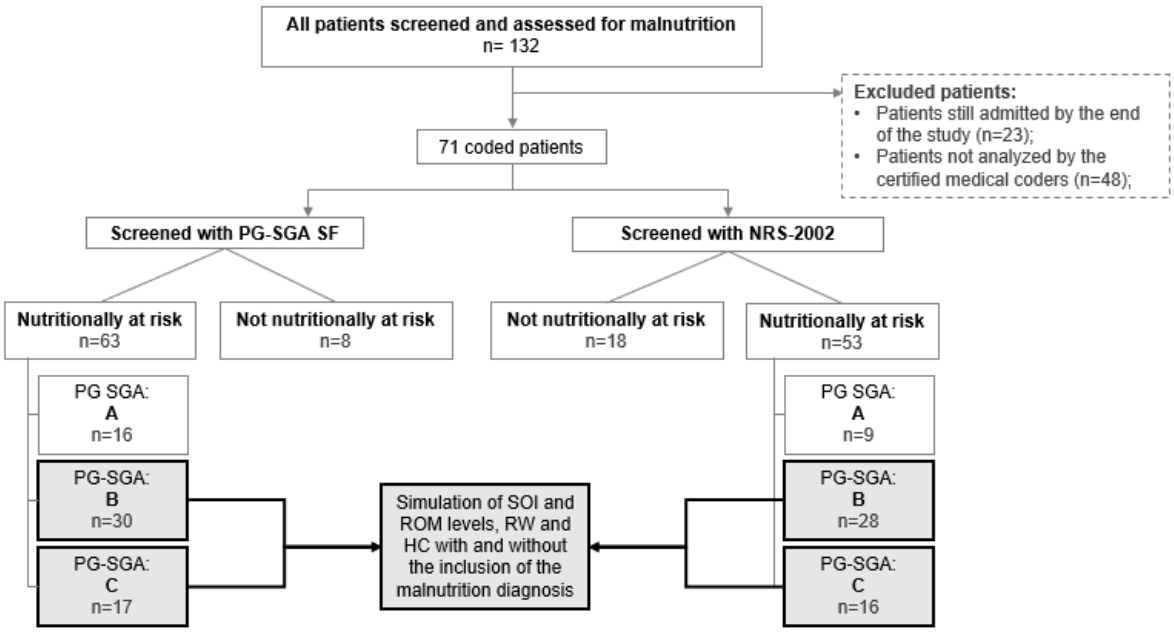
Abbreviations:

LOS = Length of stay

NRS 2002 = Nutritional Risk Screening 2002

PG-SGA = Patient-Generated Subjective Global Assessment

Appendix C – Flowchart for the determination of Diagnosis-Related Group code, Severity of illness and Risk of mortality level, Relative weight and Hospitalization costs



Abbreviations:

NRS 2002 = Nutritional Risk Screening 2002

PG-SGA = Patient-Generated Subjective Global Assessment

SF = Short Form

PG-SGA = Well nourished

PG-SGA B = Moderate/Suspected malnutrition

PG-SGA C = Severely malnourished

SOI = Severity of illness

ROM = Risk of mortality

RW = Relative weight

HC = Hospitalization costs

Appendix D – Characterization of coded patients according to their nutritional status (n=71)

	Total (n=71)	**Well nourished** (n=24)	**Malnourished** (n=47)	***P* value**
Sex, n (%)				0.561[a]
Male	38 (53.5%)	14 (58.3%)	24 (51.1%)	
Female	33 (46.5%)	10 (41.7%)	23 (48.9)	
Age, years[1]	74.87 ± 13.81	72.42 ± 13.49	75.98 ± 13.96	0.307[b]
LOS, days[2]	8 (6-11)	8 (6-13)	8 (6-11)	0.574[c]
Readmitted during last year, n (%)				
Yes	19 (26.8%)	8 (33.3%)	11 (23.4%)	0.405[d]
No	52 (73.2%)	16 (66.6%)	36 (76.6%)	
Referred to clinical nutritionist, n (%)				
Yes	4 (5.6%)	1 (4.2%)	3 (6.4%)	1.000[e]
No	67 (94.4%)	23 (95.8%)	44 (93.6%)	

[1]Mean ± Standard deviation

[2]Median (Interquartile range)

[a]χ^2 test

[b]Student t-test for independent samples

[c]Mann Whitney test

[d]χ^2 test

[e]Fishers exact test

Abbreviations:

LOS = Length of stay

Appendix E – Nutritional status of the 71 coded patients

	n (%)	PG-SGA Category, n (%)	
PG-SGA SF (n=71)	**Nutritionally at risk** 63 (88.7%)	Well nourished	16 (25.4%)
		Moderate/suspected malnutrition	30 (47.6%)
		Severely malnourished	17 (27.0%)
	Not nutritionally at risk 8 (11.3%)		
NRS 2002 (n=71)	**Nutritionally at risk** 53 (74.6%)	Well nourished	9 (17.0%)
		Moderate/suspected malnutrition	28 (52.8%)
		Severely malnourished	16 (30.2%)
	Not nutritionally at risk 18 (25.4%)		

Abbreviations:

NRS 2002 = Nutritional Risk Screening

PG-SGA = Patient-Generated Subjective Global Assessment

SF = Short Form

Appendix F – Risk of mortality level with and without the malnutrition diagnosis in patients nutritionally at risk according to PG-SGA SF (n=47)

		ROM level with malnutrition (n)				**Total**
		1	**2**	**3**	**4**	
ROM level without malnutrition (n)	**1**	3	4	0	0	7
	2	-	11	4	0	15
	3	-	-	20	2	22
	4	-	-	-	3	3
Total		3	15	24	5	47

- Number of patients whose ROM level without malnutrition = ROM level with malnutrition

- Number of patients whose ROM level without malnutrition < ROM level with malnutrition

Abbreviations:

ROM = Risk of mortality

Appendix G – Risk of mortality level with and without the malnutrition diagnosis in patients nutritionally at risk according to the NRS 2002 (n=44)

		ROM level with malnutrition (n)				**Total**
		1	**2**	**3**	**4**	
ROM level without malnutrition (n)	**1**	3	4	0	0	7
	2	-	10	4	0	14
	3	-	-	18	2	20
	4	-	-	-	3	3
Total		3	14	22	5	44

- Number of patients whose ROM level without malnutrition = ROM level with malnutrition

- Number of patients whose ROM level without malnutrition < ROM level with malnutrition

Abbreviations:

ROM = Risk of mortality

Appendix H – Severity of illness level with and without the malnutrition diagnosis in nutritionally at risk patients according to PG-SGA SF (n=47)

		SOI level with malnutrition (n)				**Total**
		1	**2**	**3**	**4**	
SOI level without malnutrition (n)	**1**	0	1	1	0	2
	2	-	5	12	0	17
	3	-	-	19	5	24
	4	-	-	-	4	4
Total		0	6	32	9	47

- Number of patients whose SOI level without malnutrition = SOI level with malnutrition

- Number of patients whose SOI level without malnutrition < SOI level with malnutrition

Abbreviations:

SOI = Severity of illness

Appendix I – Severity of illness level with and without the malnutrition diagnosis in nutritionally at risk patients according to NRS 2002 (n=44)

		SOI level with malnutrition (n)				**Total**
		1	**2**	**3**	**4**	
SOI level without malnutrition (n)	**1**	0	1	1	0	2
	2	-	5	12	0	17
	3	-	-	17	4	21
	4	-	-	-	4	4
Total		0	6	32	9	44

- Number of patients whose SOI level without malnutrition = SOI level with malnutrition

- Number of patients whose SOI level without malnutrition < SOI level with malnutrition

Abbreviations:

SOI = Severity of illness