Title: Direct health care costs associated to neurological diseases and different degrees of malnutrition

Running title: Direct health care costs according to degree of malnutrition

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Abstract

Background and Aims: Home-based care and oral supplemental nutrition may be an efficient way of managing health resources, freeing up hospital resources and improving patient care and quality of life. For some conditions, such as neurodegenerative diseases and acute neurological conditions, adequate nutritional control of patients at the time of discharge, with home monitoring by a home hospitalization unit (HHU), coupled with the introduction of necessary and appropriate oral nutritional supplements for each patient, is a good strategy for ensuring the efficiency of health resources. The aim of this paper is to analyse the direct health costs, considering home care and oral nutritional supplement, of patients with newly diagnosed neurological diseases and at risk of nutritional problems.

Methods: A study was designed to measure direct health care costs of patients with neurological related diseases according to their different nutritional needs. The sample for this study consisted of all patients (n=100) of the Elda University Hospital in Elda, Spain, with newly diagnosed neurological pathology and suspected malnutrition at hospital discharge during a six months period. These patients were included in a home base care program and given oral nutritional supplements afterwards. The nutritional intervention consisted in giving nutritional supplements according to nutritional patients' needs through a home-based care unit. Nutritional needs could comprise from protein-calorie malnutrition to at risk of malnutrition. Descriptive health care costs analysis was carried out accounting for the nutritional status. Costs are expressed in 2018 euros and for a total time horizon of one year, six months of classical inpatient care and six months of home care monitoring with a nutritional intervention.

Results: Mean direct health care cost for neurological patients in the six months of classical inpatient care was €8,309.30 and, the direct healthcare cost of treating these

patients according to their nutritional needs from a home care unit was €2,970.18. The subgroup of patients that most benefited from the nutritional intervention and monitoring from the home care unit were those who were in a state of protein-calorie malnutrition or at risk of malnutrition. Under the log transformation of the variables, the Shapiro-Wilk test showed significant differences in mean costs at the 5% level for the two time periods for those suffering from protein-calorie malnutrition or at risk of malnutrition.

Conclusions: It is important to measure and economically quantify the direct health care costs of patients with neurological diseases in order to be able to evaluate different hospital and home-care interventions according to different nutritional needs. Oral nutritional supplements and monitoring by the hospital home care unit could be associated with saving money when patients have protein-calorie malnutrition or at risk of malnutrition. Therefore, direct health costs information is needed to future evaluate these different management interventions.

Keywords: direct healthcare costs, home-based hospital care, neurological pathologies, oral nutritional supplements

Introduction

Total health spending is growing faster than gross domestic product worldwide – around 4% faster in high-income countries [1]. In recent years, population ageing, advances in technology, changes in morbidity patterns and other socio-demographic developments have exerted constant upward pressure on health spending in all countries [2-4]. However, evidence from various countries suggests that up to one fifth of health spending is wasteful and could be reallocated to better use [2].

In this context, the opportunity cost of hospital healthcare spending should be minimized, and traditional management systems should be reviewed. Home-based care may be a more efficient way of managing health resources, freeing up public hospital resources for alternative uses and improving patient care and quality of life [2;5]. For some conditions, such as neurodegenerative diseases and acute neurological conditions with significant neurological sequelae, home monitoring by a home hospitalization unit (HHU), coupled with nutrition monitoring with the introduction of necessary and appropriate nutritional supplements for each patient when they are discharge, might be a good strategy for ensuring the efficiency of health resources [6-7]. Home-based services monitoring and nutritional interventions could thus become a cost-control method.

The prevalence of hospital malnutrition is high and leads to increased healthcare costs. The importance of addressing malnutrition in post-hospital phases has been highlighted and recommendations have been made for tackling malnutrition as a public health problem [8]. Malnutrition in home-based care is a major problem and dealing with it requires a multidisciplinary approach [9]. Although data vary across studies, available evidence shows that early nutrition intervention can reduce complication rates, length of hospital stay, readmission rates, mortality and cost of care [6;10]. The key is

to systematically identify patients who are malnourished or at risk and to promptly intervene.

In order to evaluate different patient management strategies, information on costs need to be calculated. This study responds to the need to evaluate and measure the direct health care costs achieved by a nutritional intervention implemented and monitored by the home-based care among patients with disabling neurological diseases – some with suspected protein-calorie malnutrition or at risk of malnutrition at the time of diagnosis. There is no published evidence on the direct healthcare costs that could be generated before and after offering patients with protein-calorie malnutrition or at risk of malnutrition, the opportunity to be treated with oral nutritional supplements and monitored by home based care unit. However, there is evidence that administering oral nutritional supplements (ONS) to malnourished elderly patients is associated with a lower risk of hospitalization and lower healthcare costs [12]. The main objective of this study was to analyse and measure direct health care costs for patients suspected of protein-calorie malnutrition or at risk of malnutrition, who receive oral nutritional support and care through a home care unit after six months of receiving traditional hospital care management.

Materials and Methods

Study population

A study was designed to measure direct health care costs of patients newly diagnosed with neurological related diseases with or suspected of malnutrition problems. For all these patients, two types of costs were evaluated: costs for an earlier stage of classical inpatient care traditional hospital management (pre-home care period with no nutritional intervention), and costs for a subsequent stage of home care (post-

home care period with a nutritional intervention and their corresponding monitoring). All patients arriving to the traditional hospital care unit with this diagnostic were selected during six months. Therefore, the sample for this study consisted on the total number of patients (n=100) with recently diagnosed neurological pathology and suspected of having protein-calorie malnutrition or at risk of malnutrition at the Elda University Hospital discharge (Alicante, Spain). The inclusion criterion was patients with newly diagnosed neurological pathology and suspected malnutrition at hospital discharge that were given oral nutritional supplements and a home base monitoring of this intervention. Patients were admitted to the hospital due to the main diagnosis of the study (acute cerebrovascular accident or neurodegenerative disease.) and, at hospital discharge, health professionals suspected malnutrition or oral nutrition problems and sent these patients for home-based care monitoring programme. Home care included two visits in six months. An initial one at the time of inclusion at home care, with a complete nutritional analysis and assessment, and another at 3 months with a new analysis and nutritional assessment. Figure 1 shows a flow chart to explain patients' pathway.

<Figure 1>

Some patients did not have nutritional risk before hospital admission, so they were well nourished. These patients, due to the neurological problem suffered (for instance dysphagia), they were admitted to the hospital. Therefore, these patients suffered protein-calorie malnutrition or were at risk of malnutrition at discharge. Not providing oral nutritional supplementation at home base care, could have ended up with all these patients malnourished. For other patients, the hospital admission was caused by a complication of the diagnose, such as the need of bronchoaspiration for dementia

patients. Therefore, these patients were previously malnourished but without an appropriate diagnose.

Data collection

The Clinical Research Ethics Committee of the hospital considered that there was no need for their study approval because there was no clinical trial with an intervention comparing two groups. Patients gave verbally ethics approval to their study participation when they were admitted to the home hospital. All patients approached (N=100) agreed to participate in the study. As all included patients had the ability to swallow, oral nutritional supplements were used. Data was collected from the electronic medical record of the health regional government, but also through an own database to facilitate its collection, exploitation and evaluation, since the different data such as pathologies, stays, body mass index (BMI) according to WHO definition [13], biochemical data, etc. were pooled from different databases from the health regional government. Only the Malnutrition Universal Screening Tool (MUST) and the Mini Nutritional Assessment (MNA) were collected additionally. The MUST was completed at the time of discharge. Those who were positive and agreed to participate in the study in the first home visit completed the MNA, to assess their nutritional status, and the analytical and anthropometric measurements. The patients were not diagnosed with malnutrition, they were at risk of malnutrition, that is why the MUST was performed upon discharge. Total time horizon of the analysis was one year; therefore, no discount rate was applied. The costs analysed for these patients related to the 6 months prior to their inclusion in the study, during which they were under traditional hospital care, and the 6 months following their inclusion, when they were receiving a supplemental oral nutritional intervention through the HHU.

Some of these patients had high or medium risk of nutritional problems at the time of inclusion, while others were at risk of being malnourished. Patients having medium nutritional problems at the time of discharge were patients who were previously well nourished and who, because of being admitted for a neurological disease, has suffered a difficulty for nutrition (beginning of a slightly malnourished) and in the immediate future if no intervention begins the nutritional problem will get worse. However, severe nutritional problems were those patients who suffer long-standing neurological pathology prior to admission (dementia, Alzheimer, etc.) and who already had malnutrition prior to admission but did not receive any nutritional supplement before, and this condition worsens during the hospital admission. This previous malnutrition became severe at discharge. This comparison pre-home care (having a nutritional problem in the hospital setting but not addressing it in hospital as well as home) with post-home care (supplemental nutrition in the home setting) evaluates the association with public health care costs and its implications.

Direct health care costs

Use of health resources (drugs, procedures, nutritional supplements, hospital admissions for a specific diagnosis, hospital stays and emergencies) were quantified and assessed in both stages (the “pre” stage, before moving from hospital to home care, and the “post” stage, when the patient was receiving care through the HHU) and, according to MNA results [14]. The mean total direct healthcare costs were calculated for both periods, pre and post, and according to the patients’ nutritional status and the mean cost of each of the various health resources used. To calculate the costs of the different drugs and oral nutritional supplements, the real doses of each drug for each patient were used, adjusted by the retail price of these drugs or supplements, based on the published list price for each product. The dose in all patients was 2 packs, of 200ml each, of a

powdered oral nutrition supplement, every 24 hours, for 3 months. The costs of medicines dispensed were calculated, not those of medicines consumed or withdrawn from the pharmacy. The costs of the various procedures, hospital admissions for a specific diagnosis, hospital stays and emergencies were calculated on the basis of the resource units consumed, as reported by the Elda Hospital, and their prices were calculated using the official rates for these resources published by the Generalitat Valenciana (the government of the autonomous community of Valencia) (see Table S1 in the annex/supplementary material). The exact date of the procedures is not known, but it was possible to determine whether they had occurred in the pre-stage, while the patient was receiving inpatient care, or the post stage, while the patient was receiving care through the HHU. All costs are expressed in 2018 euros and for a time horizon of six months, after the start of home care.

Statistical analysis

Patients' socio-demographic characteristics, health status, diet and other variables were analysed. A descriptive statistical analysis of these variables was carried out, using tables in the case of categorical variables and descriptive numerical summaries for quantitative variables.

In terms of statistical analysis, a paired mean difference test was carried out to compare the mean values of direct healthcare costs before and after being treated through the home-base care unit, and according to patient nutritional status (MNA results), in order to ascertain whether there were statistically significant changes between the two stages. Where the target variable (the difference variable) was normal, the Student *t*-test was performed for paired samples. Where the assumption of normality was not met, the Shapiro-Wilk test, a nonparametric test, was used for evaluating whether the observations deviate from the normal curve, so to check the normality

assumption. In the software used (STATA 16), there is the option to test whether after log transformation the normality assumption holds. This option was used, and therefore standard Shapiro-Wilk test evidenced not normality but the log transformation did.

For each of the variables, the dispersion or variability expressed by standard deviation is shown.

Results

Tables 1a and 1b show the distribution of relative frequencies of the group of variables related to socio-demographic characteristics and the results of the MUST test. The sample included more women than men, 63% and 37% respectively, and the 59% of the total sample lives independently at home.

<Table 1a> <Table 1b>

As Table 1a shows, 64% of patients had neurodegenerative diseases. From those, 78% (n=50) had high or medium risk of malnutrition problems. Compared to neurodegenerative diseases diagnose, patients diagnosed with Acute Cerebrovascular Accident (ACVA) had same percentage of patients with high or medium risk of nutrition problems (78%). From patients having neuropsychological disorders, 78% had dementia and 72% had suffered from stress during the last three months of the pre-home period. As measured by the MUST, 94% were at high or medium risk of malnutrition problems, and only 9% were able to leave their homes; 63% had a body mass index (BMI) of under 21. In terms of health status after the move to home care and the initiation of oral supplements compared with health status before, 67% answered “I don’t know”.

<Table 1c>

Table 1c reflects various nutrition-related variables. As the figures show, 34% of patients had lost some weight, 61% had eaten less, 65% needed help to eat and 75% were moderately malnourished.

Table 2 below shows the distribution of the remaining characteristics of the sample, which were measured by numerical variables.

<Table 2>

The table shows the mean, minimum, maximum and standard deviation values. It should be noted that the age range was very wide (between 52 and 97 years), although the mean was 83 years. The mean weight was around 57 kg and the mean MNA test score was around 14 points.

The results of the cost analysis without considering patients' nutritional status can be seen in Table 3, which shows the mean cost of drugs, procedures, oral nutritional supplements, hospital stays and emergencies, calculated for the full sample. It also summarizes the mean total direct healthcare costs for the pre- and post-home care periods.

Table 3 shows lower mean total direct healthcare costs for the pre-home period compared to the post-home care period.

<Table 3>

Compared with the traditional hospital care management, patients spend more on medication and supplemental nutrition during the home care management. The post-home care period shows a lower healthcare costs related to procedures, hospital admissions by diagnosis, hospital stays and emergencies. The standard deviation of the mean total direct healthcare costs is also greatly reduced, by almost 50%, between the pre- and post-home care periods. The mean total direct healthcare costs, in the pre-home care model, amounted to €8,309.30, while for home care the figure was €2,970.18. The

distribution of costs in the post period was much more homogeneous than in the pre-home care period, indicating lower mean costs in the post period.

In the pre-home care period the costs are higher mainly for two reasons. First, it corresponds to the initial diagnosis of the disease that triggers admission and therefore more diagnostic tests are done, especially imaging tests. And, second, from the moment they enter in the HHU, patients receive medical assistance and follow-up at home, so possible complications derived from their disease, such as new infections, bronchial aspirations, etc., are treated very early and, therefore, they do not progress to a more serious stage and therefore do not require hospital admission. All patients requiring hospital admission are immediately referred to the hospital by HHU doctors, referred earlier because they are closely controlled at home, so hospital stays are shorter and do not require as many diagnostic tests. Therefore, all patients are in the same health system and are admitted to the same hospital in the pre-home care and post-home care period, the difference is that once the HHU controls them at home, the complications are less. They are diagnosed earlier, and are not as severe as in the pre-home care period, in which the patients were attended in the hospital and the clinical or health state they have when they arrive to the hospital is worse. This greatly reduces hospital stays and testing in the post-home care period.

When direct healthcare costs for the pre and post home care period were calculated considering the patients' nutritional status (MNA results) (Table 4), the pattern of results was maintained, although the sample was split between 22 patients with adequate nutritional status and 78 patients with protein-calorie malnutrition or at risk of malnutrition. More detailed results, by type of direct healthcare cost and type of health resource used are shown in Table 4.

<Table 4>

Total direct healthcare costs in the pre-home-care period for patients with adequate nutritional status were €7,872.31, while for patients with protein-calorie malnutrition or at risk of malnutrition the costs amounted to €8,432.55. For the period in which patients were already in-home care, patients with adequate nutritional status had a mean total direct healthcare cost of €2,792.5 and patients with protein-calorie malnutrition or at risk of malnutrition had a mean cost of €3,600.12. Figures 2 and 3 show the relative percentages for each type of direct healthcare cost by patient nutritional status for the pre and post periods.

<Figures 2 and 3>

Compared with the adequate nutritional status patients, those with protein-calorie malnutrition or at risk of malnutrition consumed less medication, had fewer diagnostic tests and, had more hospital admissions and stays during the pre-home care model. In addition, compared with the adequate nutritional status patients, those with protein-calorie malnutrition or at risk of malnutrition and ACVA has less mean number of admissions and longer hospital stays during the home-care stay. However, those compared with those with protein-calorie malnutrition or at risk of malnutrition, those with adequate nutritional status and neurodegenerative diseases had fewer emergencies during the home-care management. The age groups that most benefited in terms of reduction of mean number of admissions following the move from traditional hospital management to home care were those between 70 and 90 years of age who had protein-calorie malnutrition or at risk of malnutrition.

Various statistical tests were carried out to confirm that these differences in mean total direct healthcare costs between pre and post home care periods really existed. When we compared the mean total direct healthcare costs for the pre and post periods for patients without malnutrition problems, using the Student *t*-test, the null

hypothesis – i.e. that there would be no difference in the mean costs for the two periods ($p = 0.01$) – was rejected. Likewise, when we did the same test to compare mean costs for the pre and post home care periods for patients with protein-calorie malnutrition or at risk of malnutrition, significant differences were found ($p = 0.00$), and the null hypothesis of equality of mean costs was again rejected. Therefore, there were differences between the mean costs of the pre and post home care management.

Figure 4 shows the differences in mean total direct healthcare costs between the pre and post home care periods, considering patients' nutritional status. This figure shows the turning point rise, which was approximately 2300€, so the point where the average total costs was reduced.

<Figure 4>

If we look at the distribution of the various mean direct healthcare costs, we see that these variables do not seem to be distributed according to a normal statistical distribution, so the difference test could be inconclusive or invalid. In fact, it is clear from the results of the Shapiro-Wilk test ($p = 0.00$) that the null hypothesis – that the variables would follow a normal distribution – is rejected. This is important in order to correctly assess whether or not there are differences between mean direct healthcare costs in the pre and post periods. Another Shapiro-Wilk test confirmed that the distribution of direct healthcare costs is logarithmic ($p = 0.93$). We therefore performed a non-parametric test of equality between dependent samples and again found differences in costs between the pre and post home care periods, both for patients with protein-calorie malnutrition or at risk of malnutrition ($p = 0.00$) and for those with adequate nutritional status ($p = 0.02$).

Table 5 shows patients' admission diagnosis.

<Table 5>

In the pre-home care model, the most frequent diagnoses, and also those associated with the highest direct healthcare costs, were bronchopneumonia, ACVA and, urinary tract infection. If we compare the costs generated by admissions for these causes in the sample for this study (N = 100) in the pre and post periods, we find that the number of admissions decreases, leading to a large reduction, of approximately 85-95%, in direct healthcare costs for the national health system.

Discussion

This study provides evidence about the direct health care costs associated to neurological diseases, regarding nutritional status and being under the classical hospital care management and home-based care monitoring. The results of this study highlight the importance of measuring costs in order to future evaluate different interventions [15] related to different management strategies for patients with neurological diseases, such as home care monitoring and nutritional interventions. Such findings have additional application given scenarios necessitating home care such as through the COVID 19 pandemic to both reduce exposure to potentially vulnerable patients, as well as reduce work within the hospital (with the hospital activity able to be diverted to another priority activities).

In terms of human resources, this change in the management of patients with neurodegenerative diseases and acute neurological conditions with significant neurological sequelae would require, as a minimum, one member of the hospital administrative staff and an HHU staff with knowledge of the applicable nutrition protocol. The experience in this Spanish hospital, such as the Elda University Hospital, could provide an example of what changes are needed in home hospitalization units to be able to provide such home base care services to patients. However, the implementation of these changes is more a matter of willingness on the part of the

organization/institution than of specific resources. In addition, results from this analysis indicates that patients with adequate nutritional status consumed more medicines. This could also imply that many people could not take their medication at home, and there might be a need for more checking or reinforcement adherence to medicines, and so a further need of human resources for home base care monitoring. This is an important learning and could be considered or further strengthened for a successful model of care into the future.

There is little evidence concerning how health professionals can, through the existing healthcare structure, individualize nutritional care for the elderly. A recently published article [16] shows that hospitals can, through a home care unit, improve patient health and reduce hospital costs, especially among patients with high or medium risk of malnutrition problems. Findings of this study could be used to evaluate future costs related to different interventions on the patients' monitoring strategies. are consistent with the results found in this study. It is important to provide close nutritional care for older people, and it is also important for hospitals to be respectful of the nutritional needs of each patient [16], but especially for patients with high or medium risk of nutritional problems and complex diagnoses.

In a large cohort of malnourished adult patients, the rate of oral nutritional supplementation (ONS) was low but, when used, ONS was associated with 38.8% fewer 30-day hospital readmissions [17]. This association was even stronger in the case of oncology patients. Shorter duration of hospital stays was observed when the interval between admission and the initiation of ONS was shorter. The authors in the Mullin study also found that reduced lengths of stay and readmission rates could generate financial benefits for health care systems that prioritize hospital nutritional care, in

addition to yielding significant medical benefits for the patients. These results should be potentially evaluated in a future study using patients' data.

One of the important limitations of this study is that data were not available for two different groups of patients: in one receiving traditional hospital management and, in another receiving home care with oral nutritional support. Therefore, neither the comparison or an association between costs of the two periods of time with different patient management strategies could have been carried out. However, we did have access to information from the Elda University Hospital in Elda, Alicante, Spain on all patients in the cohort with neurodegenerative diseases and acute neurological conditions with important neurological sequelae. This gave us a data series with very low uncertainty and high reliability, although the sample could be considered limited for a restricted period of time. Another limitation in this analysis was the no possibility of commenting on whether people were provided with nutritional supplements, how much they required and how much they consumed. This information would be relevant to describe the characteristics of the service delivery model, such as the dose of oral nutrition supplements that should be provided.

Future research might assess the economic efficiency of a nutritional intervention, comparing a group of patients receiving the intervention with another one that does not. We found a study that evaluated the cost-effectiveness of a specialized oral nutritional supplement in malnourished older hospitalized patients [18]. The study compared a nutrient-dense supplement containing high protein and β-hydroxy-β-methylbutyrate to placebo. The findings suggest that the investigative ONS is a cost-effective means of extending the lives of malnourished hospitalized patients, reaffirming the results found in our research. On the other hand, in order to measure and evaluate the specific costs of malnutrition and the potential savings for the health care

system when avoiding this health problem, there is a need for using the existing DRG for malnutrition. This would help to recognise this as a specific diagnostic.

Post-discharge care coordination and in-home care services require wide-ranging health systems reforms that cannot be initiated either by hospitals or by regions alone [2]. Rather, general reforms across countries are needed in order to tackle this public health problem, especially since nutritional problems of individuals go beyond the affected individual and also involve the patient's carers and family members.

In summary, HHU's compared to traditional hospital care with no oral nutritional supplementation, found statistically significant associations between decrease in procedures, hospital admissions and stays, and emergency care, as well as in mean total healthcare costs for patients with neurological diseases that are firstly treated with classical hospital care and then treated with oral nutritional supplements through home care management the mo. Greater implementation of a home-based nutritional monitoring programme, with oral nutritional supplementation, in malnourished neurological patients in the future is anticipated to provide significant savings to the health system compared with traditional hospital care. But, this is something to evaluate in future research.

Acknowledgements: The authors are grateful to the reviewer's valuable comments that improved the manuscript.

Statement of Authorship: BB designed the study and MTB managed it. TM carried out the statistical analysis. All authors (BB, TM, MTB) have interpreted the analysis and the results. MTB wrote the first draft of the manuscript, but all authors (BB, TM, MTB) provided substantial input and approved the final version.

Conflict of Interest Statement: There are no conflicts of interest for any of the authors of this paper.

Funding sources: This study was financed by Nutricia. Category 1: The funders had no influence on the conduct of this study or the drafting of this manuscript.

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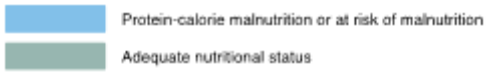
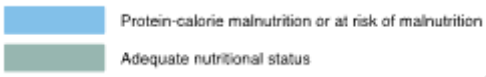
Figures' legend

Figure 2. Percentage of direct healthcare costs by patient nutritional status for the pre-home care period



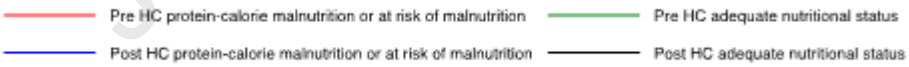
Source: Elda Hospital data.

Figure 3. Percentage of direct healthcare costs by patient nutritional status for the post-home care period



Source: Elda Hospital data.

Figure 4. Mean total direct healthcare costs for the pre and post periods by patient nutritional status



Source: Elda Hospital data.

Table 1a. Socio-demographic descriptive variables

Sex	Female	63%
Lives independently at home	Yes	59%

Table 1b. Health status descriptive variables of patients' health status in the pre-home care period (6 months)

Disease grouping	ACVA	36%
	Neurodegenerative	64%
Acute illness/stress last 3 months	Yes	72%
Neuropsychological disorders	Dementia or severe depression	32%
	Moderate dementia	46%
	No psychological problems	22%
Has skin sores or lesions	Yes	68%
MUST	Low risk of nutritional problems	6%
	Medium risk of nutritional problems	0%
	High risk of nutritional problems	94%
Patient BMI	<18.5	14%
	[18.5-24.9]	61%
	>24.95	25%
Patient mobility	From bed to chair	67%
	Autonomy within the home	24%
	Able to leave home	9%
Arm circumference (cm)	<21	22%
	>22	59%
	[21-22]	19%
Calf circumference (cm)	<31	74%

	>31	26%
Takes more than 3 medicines a day	No	70%
Comparative health status	Worse	25%
	Same	7%
	Better	1%
	Doesn't know	67%

Note: ACVA (acute cerebrovascular accident); MUST (Malnutrition Universal Screening Tool); BMI (Body Mass Index)

Table 1c. Diet/nutrition-related descriptive variables of patients' health status in the pre-home care period (6 months) (N=100)

Recent weight loss (kg)	>3	14%
	[1-3]	20%
	None	45%
	Doesn't know	21%
Loss of appetite	Has eaten a lot less	12%
	Has eaten less	49%
	Has eaten the same amount	39%
Number of meals per day	1	18%
	2	15%
	3	67%
Liquid intake	< 3 glasses	22%
	[3-5]	58%
	> 5 glasses	20%
Consumption of dairy products, eggs, meat, fish	Yes to 0 or 1	29%
	Yes to 2	41%
	Yes to 3	30%
Fruits or vegetables at least twice a day	Yes	63%
Means of eating	Needs help	65%
	Alone with difficulty	26%
	Alone without difficulty	9%
Nutritional status (MNA assessment results)	Protein-calorie malnutrition	3%
	At risk of malnutrition	75%
	Adequate nutritional status	22%

Table 2. Other descriptive numeric variables (N=100)

Variable	Minimum	Maximum	Mean	Standard deviation
Age	52	97	83.12	9.58
Height in cm	137	179	160.05	8.72
Weight in kg – pre	34	92	56.94	12.81
Weight in kg – post	37	90	57.80	11.49
Total MNA score	4	23.5	14.20	3.50
Ankle-knee length	35	58	45.20	5.60

Note: MNA (Mini Nutritional Assessment)

Table 3. Direct health costs for the pre- (6 months) and post-home care (6 months) periods

Costs (€ 2018)	Pre-home care (*N* = 100)		Post-home care (*N* = 100)		P differences
	Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)	
Medicines	561.88 (1,147.92)	324.75 (227.58-416.45)	616.77 (1,206.87)	331.29 (188.49-444.08)	0.11
Procedures	406.74 (764.43)	78.82 (78.82-142.01)	32.47 (147.70)	0 (0-0)	0.00***
Nutritional supplements	---	---	1,718.91 (534.76)	2047.72 (2047.72-2047.72)	0.00***
Hospital admission for specific diagnosis	3,672.90 (3,821.10)	3248.67 (2241.01-3751.53)	328.87 (1,020.71)	0 (0-0)	0.00***
Hospital stays	3,282.95 (3,774.45)	2115.3 (2115.3-2961.42)	186.15 (640.11)	0 (0-0)	0.00***
Emergencies	384.83 (352.52)	290.07 (193.38-386.76)	87.02 (141.16)	0 (0-0)	0.00***
Total direct healthcare costs	8,309.30 (7,777.67)	7014.33 (6211.95-	2,970.18 (2,000.15)	2298.15 (2174.41-2541	0.00***

		8081.88)		91)	

Source: Elda Hospital data.
Note: ***Significant at 1%; **Significant at 5%; Significant at 10%

Table 4. Direct healthcare costs for the pre- and post-home care periods by patient nutritional status (All costs expressed in € 2018)

	Pre-home care (MUST test)				Post-home care (MNA test)				P differences
Costs	**Low risk of malnutrition problems (*n* = 22)**		**High or medium risk of malnutrition (*n* = 78)**		**Adequate nutritional status (*n* = 22)**		**Protein-calorie malnutrition or at risk of malnutrition (*n* = 78)**		
	Mean (SD)	**Median (Min-Max)**	**Mean (SD)**	**Median (Min-Max)**	**Mean (SD)**	**Median (Min-Max)**	**Mean (SD)**	**Median (Min-Max)**	
Medicines	792.02 (1,652.84)	374.82 (111.42-687.61)	496.97 (964.24)	324.36 (183.40-416.45)	996.82 (1.807.31)	313.63 (111.42-687.83)	509.58 (963.81)	331.29 (183.40-432.30)	0.11
Procedures	542.98 (993.19)	82.87 (0-205.73)	368.32 (689.55)	78.82 (78.82-142.88)	83.05 (251.20)	0 (0-0)	18.20 (99.50)	0 (0-0)	0.00***

Nutritional supplements	---	---	---	---	1,790.87 (487.85)	2047.72 (2047.72-2047.72)	1,698.61 (548.51)	2047.72 (2047.72 - 2047.72)	0.00***
Hospital admission for specific diagnosis	3,324.85 (4,294.07)	2241.01 (0-3766.74)	3,771.08 (3,701.25)	3248.67 (2868.09-3751.53)	433.25 (1,160.61)	0 (0-0)	299.43 (983.95)	0 (0-0)	0.00***
Hospital stays	2,711.43 (3,121.59)	2115.3 (0-3837.01)	3,444.14 (3,942.05)	2115.3 (2115.3-2961.42)	173.07 (499.87)	0 (0-0)	189.83 (677.20)	0 (0-0)	0.00***
Emergencies	501.03 (428.93)	386.76 (193.38-593.61)	352.06 (323.50)	193.38 (193.38-386.76)	123.06 (152.68)	0 (0-0)	76.85 (137.06)	0 (0-0)	0.00***
Total direct healthcare costs	7,872.31 (8,070.23)	6740.30 (759.46-9789.10)	8,432.55 (7,742.32)	7014.33 (6128.28-8119.53)	3,600.12 (2.384.85)	2582.44 (2233.03-4208.61)	2,792.51 (1,856.64)	2262.01 (2146.91 -	0.00***

								2478.85)	

Source: Elda Hospital data.

Note: ***Significant at 1%; **Significant at 5%; Significant at 10%

Table 5. Total direct healthcare costs for the pre- and post-home care periods by admission diagnosis (All costs expressed in € 2018)

Costs	n	Pre-home care		Post-home care		P differences
		Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)	
Bronchopneumonia	**25**	10801.65 (8476.23)	8167.92 (6269.23-10549.3)	3931.99 (2695.74)	2813.52 (2467.34-4545.85)	0.00***
ACVA	**25**	8585.45 (8599.27)	7222.40 (1818.13-9546.18)	2273.45 (1154.28)	2170.66 (2022.81-2391.73)	0.00***
Urinary tract infection	**15**	5320.68 (5540.25)	5229.64 (759.06-7410.99)	2791.32 (1402.75)	2287.82 (2102.93-2887.75)	0.07*

Source: Elda Hospital data.
Note: ACVA (Acute Cerebrovascular Accident)
Note: ***Significant at 1%; **Significant at 5%; Significant at 10%