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Original/*Otros*

Cost-effectiveness of early nutritional therapy in malnourished adult patients in a high complexity hospital

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Abstract

Introduction: **hospital malnutrition is a frequent worldwide problem and its potential issues related include increased complications, length of stay, mortality, and healthcare costs.**

Objectives: **the aim of this study was to establish the cost-effectiveness of early nutritional therapy for malnourished patients in a high complexity hospital.**

Materials and methods: **this analytical study with economic assessment included 227 adult hospitalised and malnourished according to the Subjective Global Assessment. The cohort prospective received Early Nutrition Therapy (ENT), whereas the cohort retrospective received Delayed Nutrition Therapy (DNT). The measures of cost-effectiveness included costs by: length of stay, complications and discharge condition.**

Results: **the cohorts were similar in demographic and clinical characteristics, except that the median age, for the ENT was 61 years (interquartile range [IQR]: 48-71) and for the DNT was 55 years (IQR: 44-67) (p = 0.024). The median length of stay was lower in the ENT (11 days, IQR: 7-17) than in the DNT (18 days, IQR: 10-28) (p < 0.001). The cost per patient discharged alive was US $ 10,261.55 in the ENT and US $ 15,553.11 in the DNT (p=0.043); the cost per patient with complications was US $ 13,663.90 in the ENT and US $ 17,860.32 in the DNT (p= 0.058). ENT increased the likelihood of being discharged alive, RR adjusted=0.31; 95% confidence interval (CI): 0.1; 0.6; (p<0.001) and decreased the likelihood of complications RR crude=0.8; 95% CI: 0.6; 0.9; (p=0.006).**

COSTE-EFECTIVIDAD DE LA TERAPIA NUTRICIONAL TEMPRANA EN PACIENTES ADULTOS MALNUTRIDOS EN UN HOSPITAL DE ALTA COMPLEJIDAD

Resumen

Introducción: **la malnutrición hospitalaria es un problema frecuente en el mundo que aumenta las complicaciones, los días de estancia, la mortalidad y los costes sanitarios.**

Objetivos: **el objetivo de este estudio fue establecer la coste-efectividad de la terapia nutricional precoz en pacientes malnutridos en un hospital de alta complejidad.**

Materiales y métodos: **este estudio analítico con valoración económica, incluyó 227 adultos hospitalizados y malnutridos según Valoración Global Subjetiva. La cohorte prospectiva recibió Terapia Nutricional Precoz (TNP), mientras que la cohorte retrospectiva recibió Terapia Nutricional Tardía (TNT). Las medidas del coste-efectividad incluyeron costes por: días de estancia, complicaciones y condición de egreso.**

Resultados: **las cohortes fueron similares en cuanto a características clínicas y demográficas, excepto en la mediana de edad; para la TNP fue 61 años (rango intercuartil [RIQ]: 48-71) y para la TNT fue 55 años (RIQ: 44-67) (p=0,024). La TNP se encontró costo-efectiva en la reducción de los días de estancia hospitalaria (11 días, RIQ: 7-17) en comparación con la TNT (18 días, RIQ: 10-28) (p<0,001). La TNP registró costos de 10.261,55 $ US por paciente egresado vivo, inferiores a los obtenidos en la TNT 15.553,11 $ US (p=0,043); el coste por paciente con complicaciones fue 13.663,90 $ US en la TNP y 17.860,32 $ US en la TNT (p=0,058). La TNP incrementó la probabilidad de egresar vivo, RR ajustado=0,31; intervalo de confianza (IC) 95%: 0,1; 0,6; (p<0,001) y disminuyó la probabilidad de complicaciones RR crudo=0,8; IC 95%: 0,6; 0,9; (p=0,006).**

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Conclusion: **early nutritional therapy for malnourished adult patients appears to be cost-effective because it can reduce the length of stay, complications, mortality and associated costs.**

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Key words: *Cost-effectiveness. Malnutrition. Nutritional therapy. Complications. Length of stay.*

Conclusión: **la terapia nutricional precoz en pacientes adultos malnutridos parece ser coste-efectiva porque puede reducir los días de estancia, las complicaciones, la mortalidad y los costes asociados.**

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Palabras clave: *Coste-efectividad. Malnutrición. Terapia nutricional. Complicaciones. Días de estancia.*

Introduction

Hospital malnutrition is a frequent problem worldwide, with reports showing rates ranging from 20% to 63% depending on the method used to assess nutritional state[1-3]. A study in Spain found that 46% of patients were malnourished according to a subjective global assessment[4]. The Latin American Nutrition study (ELAN) showed that 50.2% of hospitalised patients had some type of malnutrition[5]. In Colombia, the frequency of malnutrition is reported to be 63% to 64%[6,7].

Hospital malnutrition or Disease-Related Malnutrition (DRM)[8] is a problem that is underestimated by health administrators and medical personnel, despite its grave implications to patients and health systems. Potential issues related to DRM include increased complications, length of stay in the hospital, mortality, and healthcare costs, as well as delayed wound healing, decreased tolerance to treatment, and reduced quality of life[9-11].

Several nutrition assessment tools exist to diagnose malnutrition, the Subjective Global Assessment (SGA) is one of the most commonly used which includes features of patient history and features of physical examination[12]. The SGA is a simple and fast evaluation method that allows malnourished patients to be identified before changes occur in indicators such as the body mass index[13]. Once DRM is identified, nutritional intervention is required, and its effect should be measured. Considering that effectiveness is one of the dimensions of quality of care[14], Cost-Effectiveness analysis (CEA) is used as an analytic tool in which the costs and effects of an intervention are compared with an alternative strategy[15]. Thus, it is essential for healthcare services to include nutritional therapies with cost-effective added value, which has important consequences for the efficient use of resources[16].

Nevertheless, even though the cost of medical care has increased considerably at the global level in recent years, the CEA does not appear to be a technique that is often utilised for decision-making within health systems; given its conceptual and methodological complexity, resource allocation and cost containment are guided by strategies such as capitated contracts or volume discounts[17].

Although the negative clinical results of DRM are well known, these effects are in most cases reversible through nutrition therapy (oral, enteral and parenteral) and few studies have evaluated the economic benefit of such strategies[18-20]. Thus, from an institutional point of view, the objective of this study was to establish the cost-effectiveness ratio of early versus delayed nutritional therapy for malnourished adult patients in a healthcare institution of high complexity.

Materials and methods

An analytical cohort study with economic assessment was conducted between 2010 and 2012 at the Pablo Tobón Uribe Hospital in Medellín, Colombia.

The inclusion criteria for this study consisted of patients with ages between 18 and 80 years, a minimum length of stay of 4 days in the hospital, and moderate or severe malnutrition according to the SGA.

The exclusion criteria consisted of pregnant women, terminal patients, patients with a length of stay longer than 100 days and patients with medical indication of nil by mouth (NPO).

Patients receiving nutritional therapy were evaluated by the hospital nutrition support team while patients receiving a therapeutic diet were evaluated per standard practice. The early nutritional therapy (ENT) prospective cohort comprised patients who were admitted between August 2011 and July 2012. These patients met all inclusion criteria and received nutritional therapy within the first 48 hours after emergency admission according to FELANPE (FederaciónLatinoamericana de Nutrición Parenteral y Enteral [Latin American Federation of Parenteral and Enteral Nutrition]) standards[21]. Patients were followed until discharge; the data collection format was designed and used for taking information about patient. The delayed nutritional therapy (DNT) retrospective cohort comprised patients meeting all inclusion criteria who received nutritional therapy more than 48 hours post-emergency admission or received a therapeutic diet because they were later referred to a professional in nutrition and dietetics at the time of discharge. For this cohort, the hospital's information management department provided a list of hospital discharges from the year 2010 until July of 2011 for patients aged 18 - 80 years with a length of stay of at least 4 days; the discharge list and the electronic

clinical history were reviewed simultaneously by researchers to select the participants with moderate or severe malnutrition according to the SGA rating documented in the medical record. To record all complications, the medical progress of patients was reviewed from admission until discharge according to the patients' medical records.

The two cohorts of patients were malnourished according to the SGA, and such classification was performed by nurses when the patient entered the hospital. The retrospective cohort of malnourished patients received delayed nutritional intervention in spite of being classified as malnourished. It was precisely to avoid ethical connotations that we had to use a retrospective cohort for that group of patients.

To evaluate the difference between prescribed and consumed nutritional therapy, an intake control was performed in patients with an oral diet plus supplements, and what was received when the prescription was enteral, parenteral, or mixed nutrition was recorded. The effectiveness of early nutritional intervention was measured through indirect variables such as length of stay, complications, and discharge condition. The length of stay was measured in days, from admission to the hospital until discharge. A complication was defined as the appearance of a condition or accidental event during hospitalisation that was independent of the cause of admission to the hospital. These complications were classified as infectious or non-infectious. Finally, the discharge condition was recorded: status at discharge, alive or dead.

Selection bias was controlled by training the researchers in the handling of electronic clinical history. Information collection and recording were standardised, and all inclusion criteria were verified. A pilot study was conducted with 10% of the sample to adjust the inclusion criteria and to improve information collection tools. The sample was probabilistic, and its size was determined by the mean difference in length of stay (2.4 ± 5.66 days) for malnourished patients before and after a screening program using data obtained from Sorensen´s study[22]. The sample was calculated with 95% confidence and 90% power for a total of 227 patients, with 113 in the ENT cohort and 114 in the DNT cohort.

Economic assessment

This analysis included only direct costs; these costs were analysed according to the diagnosis-related group (DRG), relative weight, and the DRG´s subclasses established at the institution according to the following levels of severity: major complications or comorbidities (MCCs), complications or comorbidities (CCs), and non-CCs. The 3M™ software All Patient Refined DRG (APR DRG) 2.1 version was used. The health care cost components included laboratory tests, medications, equipment, diagnostic tests, hospitalisation, materials, personnel, and surgery. To eliminate the effects of inflation on the monetary data, the values were deflated by taking the year 2012 as the base year. An Incremental cost-effectiveness ratio was calculated taking the difference in costs between the ENT and DNT cohorts and dividing this value by the difference in effectiveness between the ENT and DNT cohorts. The resulting ratio was interpreted as the costs per unit of effectiveness.

Statistical analysis

The patient database was generated using Access (Microsoft Office, USA, 2007); the statistical analysis was conducted using STATA 12.0 software (State Corp., Release 10, College Station, TX, USA).

The Chi-squared test was used for categorical variables, and the Mann-Whitney U-test was used for numerical variables with a non-normal distribution. P values < 0.05 were considered statistically significant.

The crude relative risk (RR) was calculated through bivariate analysis for complications, and both crude and adjusted RR values were calculated for the patient's discharge condition. Multiple linear regression analyses were used to find the determinants of length of stay considering unusual and influential data, the normality of residuals, homoscedasticity, linearity, multicollinearity, and model specification. The cost analysis used median and inter-quartile ranges (IQR). Two methods were used for the sensitivity analysis, Monte Carlo simulations assuming normality as parametric analysis for the logarithm of the costs in this a random sample of 30% of the data was selected and 1000 simulations for the difference in costs and effects were made. It was performed as nonparametric bootstrapping method to calculate the cost-effectiveness comparison of parts of the mean differences in costs between the group ENT and the DNT. In total, 1,000 samples were generated with corresponding confidence intervals (CI).

Finally, the DNT cohort was used to perform a sensitivity analysis with the following attention-time ranges: between 2 and 3 days; between 3 and 4 days; and more than 5 days. The same cohort was also used to estimate a logistic regression with discharge condition as the dependent variable and time range, age, sex, marital status, social security affiliation, DRG scores, complications, and length of stay as independent variables.

Ethical research management

The procedures followed were in accordance with the ethical standards of the responsible institutional committee. This study was endorsed by the ethics and research committee of the Pablo Tobón Uribe Hospital (PTUH).

Results

Patients

The general aspects of the hospital, such as the provision of services, level of complexity, number of specialties, occupancy rates, average stay, and bed rotation, did not change during the study. Additionally, the hospital nutritional care during the study was based on clinical practice guidelines implemented by nutrition and dietetics professionals.

The cohorts were similar in demographic and clinical characteristics except for the age, where the median age was higher in ENT patients. In total, 68.4% of the DNT cohort and 60.2% of the ENT cohort were treated by internists. Most patients belonged to the contributory health insurance regime (Table I).

Nutritional treatment

There were statistically significant differences in nutritional support type between the two cohorts, the 63% of the ENTcohort received oral diet plus supplements compared with the 53% of the DNT cohort p= < 0.001. The 23% of the ENTcohort received standard enteral nutrition compared with the 3% of the DNT cohort p=0.001. The parenteral nutrition route was less commonly used, 5% in the ENT cohort and 2% in the DNT cohort (p= < 0.001). None patient of the ENT cohort received therapeutic diet while the 43% of the DNT cohort if received.

In the 95% of the patients in the ENT cohort was covered more than 80% of the caloric requirement in the first week. Of the remaining patients, 5% were followed during the hospitalisation period to increase the contribution to 86%. In the DNT cohort, 52.63% of the patients achieved 86% coverage of the caloric requirement. A coverage of only 10% was achieved by 4.38% of patients, and 42.98% received a therapeutic diet without medical records of the percentage of consumption.

In total, 176 patients (113 ENT and 65 DNT) received an additional amount of energy (≈ 500 kilocalories) and 1.5-2.0 g/kg day of protein according to the Hospital practice guideline for malnutrition. Those who received a therapeutic diet received an average of 1,800 kcal and 68 g of protein.

Length of hospital stay

The ENT cohort had a shorter length of stay in the hospital (11 days, IQR: 7-17) compared to patients in the DNT cohort (18 days, IQR: 10-28), p < 0.001). Additionally, 90% of the patients in the DNT cohort were hospitalised for ≤ 43 days, whereas 90% of the patients in the ENT cohort were hospitalised for ≤ 25 days. Furthermore, for every day that an ENT patient spent in the hospital, DNT patients stayed 1.6 days.

In the multiple linear regression analysis, the F-test was statistically significant with an R-squared value of 0.425. Complications, cohort, and the natural logarithm of DRG scores were statistically significant factors, indicating that 42.5% of the hospital stay could be explained by these variables. The regression coefficient for cohort was negative, as we would expect a decreased length of stay for patients receiving ENT. The coefficients for complications and DRG scores were positive, which means that higher complications and DRG scores resulted in a longer length of stay (Table II).

Complications

Both infectious and non-infectious complications were considered. The most common complications were anaemia, pleural effusion, and gastrointestinal and electrolytic disorders, and some patients (23/227) presented multiple types of complications. In the DNT cohort, 76.3% of patients experienced some type of complication, compared to 59.6% in the ENT (p = 0.006). The bivariate analysis revealed that belonging to the ENT group was a protective factor against complications. In contrast, belonging to the subsidised health insurance regime was found to be a risk factor for complications (Table III).

The median for DRG scores and length of stay were higher in the patients with complications compared to patients without complications, this differences were statistically significant (Table III).

Discharge condition

Mortality was almost three times higher in the DNT cohort (28.9%) compared to the ENT cohort (9.7%) (p< 0.001). In addition, the bivariate analysis revealed that ENT in malnourished patients increased the likelihood of being discharged alive (RR_{crude} = 0.3; 95% CI: 0.1; 0.6; p < 0.001) (Table IV). The association between the group of explanatory variables and the discharge condition was tested using a binomial model, as the only significant variable was the cohort. Consequently, receiving ENT was found to decrease the risk of death ($RR_{adjusted}$= 0.31; 95% CI: 0.16; 0.61; p = 0.001) (Table IV).

Cost-effectiveness analysis

The median cost in the ENT group was US$9,058.00 (IQR: US$4,667.00 - US$13,347.00), and that in the DNT cohort was US$9,451.50 (IQR: US$4,516.00 - US$20,085.00). Although the difference in the median total cost was US$393.50, it was not significant (p = 0.204).

Table I
Demographic/clinical characteristics of the study population

Numerical Variables		***Cohorts***				***p-value***
		ENT (n=113)		*DNT (n=114)*		
Age (years)		*57.7±16.2[a]* *Median 61 (IQR 48-71)*		*53.5±15.1[a]* *Median 55 (IQR 44-67)*		*0.024[b]*
Categorical Variables		*ENT*		*DNT*		***p-value***
		n	**%**	**n**	**%**	
Sex	Male	68	60	59	52	0.201
	Female	45	40	55	48	
Marital Status	Single	30	27	37	32	0.800
	Married/Civil Union	68	60	62	54	
	Divorced	4	3	4	4	
	Widowed	11	10	11	10	
Social Security Affiliation	Contributory	70	62	66	58	0.533
	Subsidised	43	38	48	42	
Medical Specialty	Surgery[c]	25	22	20	18	0.621
	Haematology	0	0	1	1	
	Hepatology	1	1	0	0	
	Internal Medicine	68	60	78	68	
	Neurosurgery	1	1	3	3	
	Neurology	1	1	0	0	
	Oncology	14	12	10	9	
	Orthopaedics	1	1	1	1	
	Urology	2	2	1	1	
Nutritional Status	Moderately Malnourished	73	65	80	70	0.370
	Severely Malnourished	40	35	34	30	
DRG Subclasses	Non Complications or Comorbidities (Non-CCs)	2	2	3	3	0.406
	Complications or Comorbidities (CCs)	22	19	30	26	
	Major Complications or Comorbidities (MCCs)	89	79	81	71	

Abbreviations: ENT, early nutritional therapy; DNT, delayed nutritional therapy; %, relatives frequency, n, absolute frequency.
Definitions: Social Security Affiliation. Contributory regime: obligatory health insurance for the Colombian employed population or with pay capacity. Subsidized regime: health insurance provided by the state to poor and vulnerable population.
[a] Age mean ± standard deviation
[b] Significant by Mann-Whitney U-test
[c] Without cardiac patient undergoing surgery

In the ENT group, the cost for every patient discharged alive was US$11,274.12, whereas this cost in the DNT group was US$16,826.44 (p = 0.025). In addition, the cost of hospital stay for the ENT group was US$19,694.19, compared to US$24,078.80 in the DNT group (p = 0.021), and the cost for every patient with complications in the ENT group was US$15,012.18 compared to US$19,322.53 in the DNT group (p = 0.077) (Table V).

When the variation in cost was compared to the variation in effectiveness for each of the measurements, ENT increased the probability of a patient being dis-

Table II
Determinants length of stay

	Variables		*Cf*	*p-value*	*CI (95%)*	
Categorical	Sex[a]		-0.16	0.041	-0.31	-0.006
	Marital Status[a]	Single	0.09	0.337	-0.09	0.282
		Divorced	-0.03	0.892	-0.433	0.378
		Widowed	0.01	0.916	-0.252	0.281
	Social Security		-0.07	0.352	-0.231	0.082
	Complications		0.60	0.000	0.426	0.764
	Medical Specialty[a]	Surgery	-0.08	0.387	-0.279	0.108
		Haematology	-0.33	0.561	-1.453	0.791
		Hepatology	-0.57	0.317	-1.696	0.552
		Neurosurgery	-0.23	0.438	-0.803	0.349
		Neurology	-0.44	0.446	-1.582	0.698
		Oncology	-0.12	0.341	-0.369	0.128
		Orthopaedics	0.41	0.317	-0.392	1.203
		Urology	-0.09	0.788	-0.740	0.562
	Cohort		-0.32	0.000	-0.463	-0.171
Numerical	Age[b] (years)		-0.11	0.363	-0.342	0.126
	DRG Scores[b]		0.36	0.000	0.234	0.488

Abbreviation Cf variation coefficient
Note: R-squared (0.427); Adjusted R-squared (0.406); Root MSE (0.555)
[a] The reference levels correspond to Sex, Male; Marital status, Married/Civil Union; Social Security, Contributory; Complications, Yes; Medical Specialty, Internal medicine; Cohort, ENT.
[b] Log-transformed value.

charged alive, as this strategy was more effective and affordable than other alternatives. Furthermore, the difference in costs according to the effectiveness measurement was found to be significant in most cases (Table V).

These results were also similar to those obtained with bootstrapping (1,000 replications) for the cost-effectiveness ratio. Specifically, when patients with non-complications were discharged alive, the results showed greater effectiveness and less cost. The sensitivity analysis for DNT did not show significant differences between the effectiveness measurements and the attention-time ranges. Furthermore, the change in the probability of death was not statistically significant in regards to the time range. These results suggest that the first 48 hours are critical and that the same results cannot be achieved after this time; additionally, the delayed nutritional therapy and therapeutic diet showed the same results in the measures of effectiveness.

Discussion

Whereas the majority of previous studies have focused on comparing results between patients with and without DRM, the strength of the present study was its evaluation of hospitalised malnourished patients in terms of the clinical results associated with the costs of ENT. These results may permit the development and/or modification of nutritional care standard processes and programs.

Although the evidence for the cost-effectiveness of nutritional support remains to be established, our study can be used to demonstrate the cost savings and clinical benefits of ENTfor nutritional support, including nutritional supplements, enteral nutrition and parenteral nutrition in malnourished patients. According to these results, rapid detection of malnourished patients at admission followed by nutritional therapy and monitoring appears to be cost effective. Thus early intervention is precisely what determines that the patient receives adequate nutritional therapy according to nutritional requirements and for a longer time.

The median age for the patients in the ENT cohort was older (61 years) than that for the patients in the DNT cohort (55 years). In this study, it was observed that early nutritional therapy achieved better results in terms of length of stay, complications, and discharge condition, despite the fact that older adults generally have more diseases in addition to a worse nutritional state.

Table III
Bivariate model for complications

Categorical Variables		*Non Complications (%)*	*Complications (%)*	*n*	RR_{crude}	*CI (95%)*	*p-value*
Cohort	DTN	23.7	76.3	114	0.8	0.6-0.9	0.006[a]
	ETN	40.7	59.3	113			
Sex	Male	30.7	69.3	127	1.0	0.7-1.1	0.598
	Female	34.0	66.0	100			
Affiliation	Contributory	41.2	58.8	136	1.4	1.1-1.6	<0.001[a]
	Subsidised	18.7	81.3	91			
Marital Status[b]	Single	77.6	22.3	67	1.2	1.1 - 1.4	0.041
	Divorced	75.0	25.0	8	1.1	0.7 - 1.7	0.659
	Widowed	72.7	27.3	22	1.1	0.8 - 1.4	0.605
Discharge Condition	Dead	74.4	25.6	43	1.1	0.9 - 1.4	0.305
	Alive	66.3	33.7	184			

Numerical Variables	*Non Complications (median)*	*Complications (median)*	*IQR*	*p-value*
DRG Scores	1.25	1.85	1.06 - 3.25	<0.001[c]
Age (years)	57	59	44 - 68	0.390
Length-of-Stay (days)	7	18	5 - 27	<0.001[c]

Abbreviations: n, number of patients in that condition; CI, Confiance Interval; IQR, interquartile range.
[a] Significant by the Chi-squared test
[b] Reference level corresponds to Married/Civil Union
[c] Significant by the Mann-Whitney U-test

In particular, differences in length of stay were statistically significant between ENT and DNT patients, which may be explained by the increased intake of energy and nutrients received by ENT patients to meet demands resulting from disease.

Our results are also in agreement with those of several previous studies. For example, Kruizenga et al. showed that the length of hospital stay among malnourished patients treated after screening was lower than that among control patients[18]. Although the methodological design was not the same as that in our study, these results indicated that malnourished patients who received early nutritional therapy spent less time in the hospital. In a multicentre cohort study, Jie et al. evaluated the impact of nutritional support for patients at high risk for malnutrition, but no statistically significant differences were found in length of stay between patients who did not received nutritional support and patients who did[23]. These findings were statistically significant in our study, but it should be noted that they used Nutritional Risk Screening (NRS 2002), while we used SGA.

In a controlled intervention study using the MNA (Mini Nutritional Assessment), Rypkema et al. compared two groups of geriatric inpatients based on the administration of early interdisciplinary intervention. In contrast to our results, these authors did not observe statistically significant differences in length of hospital stay[24]. This difference may have been caused by the fact that our study included patients aged 18 years and older, while all of the patients in this previous study were senior adults, who generally have poorer health conditions.

Regarding the complications documented for patients in this study, a statistically greater proportion was found in the DNT cohort than in the ENT cohort. Evidence shows that DRM impairs the body's ability to mount an effective immune response and increases the susceptibility to infectious disease. Thus, treatment of DRM with early nutritional support and the delivery of essential nutrients can be effective at preventing infectious complications. This result is similar to that reported by Jie et al., who found a higher percentage of patients with complications in the group that did not receive nutritional support compared with the group that did[23]. In agreement with this finding, Sorensen observed more complications in patients with malnutrition and patients who were at risk for malnutrition[22]. Milne et al. performed a meta-analysis on patients with malnutrition during hospitalisation, and their results showed that the addition of nutritional supplements was a protective factor against complications[25]. In our study, the administration of ENT, which included nutritional supplements for the majority of patients, was also a protective factor against complications.

A meta-analysis in 2007 of patients with different diseases and the elderly reported a clinical improve-

Table IV
Statistical analysis for discharge condition

Bivariate Analysis							
Categorical Variables		*Dead (%)*	*Alive (%)*	*n*	RR_{Crude}	*CI (95%)*	*p-value*
Cohort	Non-DNT	28.9	71.1	114	0.3	0.1- 0.6	<0.001[a]
	ENT	9.7	90.3	113			
Sex	Male	18.9	81.1	127	1.1	0.6 -1.8	0.835
	Female	20	80	100			
Social Security Affiliation	Contributory	18.4	81.6	136	1.1	0.6 -1.9	0.690
	Subsidized	20.9	79.1	91			
Marital Status[b]	Single	13.4	86.6	67	0.6	0.3 - 1.2	0.142
	Divorced	12.5	87.5	8	0.6	0.1 - 4.1	0.616
	Widowed	27.3	72.3	22	1.5	0.7 - 3.1	0.325
Complications	Yes	32	122	154	1.4	0.7 - 2.6	0.305
	No	11	62	73			
Numerical Variables[c] (median)		*Dead (median)*	*Alive (median)*	*All*	*IQR*		*p-value*
DRG Scores		1.65	1.87	1.72	1.17 - 3.25		0.211
Age (years)		58	58.5	58	45 - 68		0.833
Length-of-Stay (days)		19.5	14	24	13 - 39.25		0.494
Binomial Analysis (n= 227)							
Variables			$RR_{adjusted}$	*SE*	*CI (95%)*		*p-value*
Cohort			0.31	0.11	0.16	0 .61	0.001
Sex			0.89	0.25	0.51	1.53	0.669
Social Security Affiliation			0.95	0.27	0.55	1.64	0.851
Marital Status[c]	Single		0.54	0.19	0.26	1.09	0.087
	Divorced		0.59	0.53	0.09	3.53	0.560
	Widowed		1.06	0.44	0.46	2.39	0.896
Complications			1.08	0.37	0.55	2.12	0.818
DRG Scores			1.10	0.09	0.94	1.30	0.219
Age (years)			1.00	0.01	0.98	1.02	0.883
Length-of-Stay (days)			0.99	0.01	0.97	1.01	0.336

Abbreviations: n, number of patients in that condition; CI, Confidence Interval; IQR, interquartile range; SE, Standard Error
[a] Significant by the Chi-squared test.
[b] The reference levels were: Marital status, Married/Civil Union.
[c] Mann-Whitney's U-test for numerical variables

ment in the patient's response when nutritional supplements were used instead of standard care. In general, these authors observeda decreased length of hospital stay, fewer complications, and lower mortality ratios[26]. These results are consistent with those of our study and may be due to the increased ease of liquid food consumption, with the advantage that oral supplements contain greater caloric and nutrient densities that contribute to a more rapid recovery of nutritional status. In addition, the Cochrane review found that nutritional supplements tend to be more effective than the provision of dietary advice[27]. Our results showed that the same benefits could be achieved not only through oral supplementation but also by using a feeding tube. Enteral nutrition decreases the negative effects of malnutrition, improves the clinical outcome of patients and saves costs to the health system[28].

In 2011, Norman et al. conducted a 3-month study in which malnourished patients received oral supplements. These authors found that the intervention was

Table V
Incremental cost, effects, and cost-effectiveness radio

Results measure		*Alternatives*	*Cost*	*Incremental Cost*	*Effect*	*Incremental Effect*	*C/E*	*ICER*	*p-value*
Discharge Condition	Alive	ENT	11,274.06		0.449		25,090.31		
		DNT	16,826.49	-5,552	0.361	0.088	46,580.66	21,490.35	0.015
	Dead	ENT	15,830.25		0.048		329,796.92		
		DNT	14,286.45	1,544	0.141	-0.093	101,322.32	228,474.60	0.623
Complications	Yes	ENT	15,012.13		0.295		65,466.00		
		DNT	19,322.56	-4,310.43	0.383	-0.088	39,169.57	26,296.43	0.077
	No	ENT	6,919.01		0.295		23,442.03		
		DNT	5,773.17	1,145.83	0.383	-0.088	15,063.34	8,378.69	0.836
Length-of-stay (mean days)		ENT	19,694.19		0.786		25,065.33		
		DNT	24,078.80	-4.385	1.286	-0.500	18,727.96	6,337.38	0.021

Abbreviations: C/E, cost/effects; ICER, cost-effectiveness ratio

cost-effective in relation to quality of life but that the intervention group presented higher costs[29]. Our study found lower costs for each effectiveness variable in ENT patients who received oral supplementation or nutritional support, and this difference between study results could be attributed to the methodological design.

A systematic review by Stratton and Elia found consistent benefits from the use of oral supplements. In particular, these benefits were related to significant reductions in mortality, infectious complications, and pressure ulcers, particularly in geriatric and critical-condition patients[26]. These findings are similar to ours, where patients with DRM who received ENT presented fewer complications and decreased mortality.

A systematic analysis of the costs of DRM and the use of oral nutritional supplements in hospital and community settings in the United Kingdom found a net cost saving through supplementation in orthopaedic surgery, elderly care, and prior to elective surgery[20]. In our study, cost savings were generated for each patient who was discharged alive after early nutritional therapy, but no savings were obtained for patients with complications.

Although this was an analytical observational study, our findings are consistent with the results of meta-analyses and clinical studies reported by Löser, which demonstrated the therapeutic benefits and cost-effectiveness of oral supplementation and enteral nutrition in patients with malnutrition, suggesting that nutritional intervention is an integral part of medical treatment[30]. Oral nutritional supplements provide clinical benefits, such as those found in our study (reduced length of stay and complications), which demonstrates that cost savings can be achieved with ENT. According to Stratton et al., the economic effects of the use of oral nutritional supplements are simple, secure, and clinically effective[31].

The clinical benefit of nutrition therapy on DRM may have a positive impact on the healthcare expenditure, thus improving public health and the sustainability of health systems in general.

One limitation of the current study is that the information on DNT cohort patients was obtained from the clinical history without the possibility for verification. Moreover, other results regarding anthropometric and/or biochemical variables were impossible to obtain, and the intake of the patients who received the therapeutic diet could not be evaluated.

Another limitation was that measures of effectiveness could have been influenced by other aspects of medical care or factors related to the patient, which were not available for this study and are difficult to control.

Finally, although all patients were malnourished, only those who received medical referral were administered nutritional support, oral nutrition plus supplements, enteral nutrition, parenteral nutrition, or mixed.

For future studies, if ethical considerations allow, we recommend controlled clinical trials. In addition, we recommend cost-utility studies that take into account the patient's quality of life in terms of social perspectives.

Conclusion

Early nutritional therapy for disease-related malnutrition adult patients appears to be cost-effective because it can reduce the length of stay, the complications, the mortality and the fluctuations associated with per-unit effectiveness costs.

Conflict of interest statement

The authors declare no conflicts of interest.

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