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ORIGINAL ARTICLE

Analysis of the health economic impact of medical nutrition in the Netherlands

K Freijer[1] and MJC Nuijten[2,3]

[1]*Medical Department, Nutricia Advanced Medical Nutrition, on behalf of the Dutch Industry of Children and Dietary Nutrition (VNFKD), Zoetermeer, The Netherlands;* [2]*Ars Accessus Medica, Amsterdam, The Netherlands and* [3]*Erasmus University, Rotterdam, The Netherlands*

Objective: A health economic analysis was performed to assess the cost-effectiveness of oral nutritional supplements (ONS), being a medical nutrition product, in the Netherlands.
Methods: This analysis is based on a comparison of the use of ONS versus 'no use' of ONS in patients undergoing abdominal surgery. The costs and benefits of the two treatment strategies were assessed using a linear decision analytical model reflecting treatment patterns and outcomes in abdominal surgery. The incremental cost difference was based on costs associated with ONS and hospitalization. Clinical probabilities and resource utilization were based on clinical trials and published literature; cost data were derived from official price tariffs.
Results: The use of ONS reduces the costs with a € 252 (7.6%) cost saving per patient. The hospitalization costs reduce from € 3,318 to € 3,044 per patient, which is a 8.3% cost saving and corresponds with 0.72 days reduction in length of stay. The use of ONS would lead to an annual cost saving of a minimum of € 40.4 million per year. Sensitivity analyses showed that the use of ONS remains cost saving compared with 'no use' of ONS. A threshold analysis on the length of stay shows that at 0.64 days, the use of ONS is still cost-effective, which is an unrealistic value.
Conclusions: This analysis shows that the use of medical nutrition, ONS in this case, is a cost-effective treatment in the Netherlands and is dominant over standard care without medical nutrition: it leads to cost savings and a higher effectiveness.
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Keywords: medical nutrition; cost-effectiveness; health economic model; oral nutritional supplements

Introduction

Nutritional depletion in Western countries is usually caused by the joint action of an underlying disease, for example, cancer and dietary deficiency (Naber *et al.*, 1997), also known as disease-related malnutrition (DRM). As a consequence, treatment should be focused not only on the disease, but also on nutritional intervention. A Dutch study found that 40% of the patients in a ward for nonsurgical patients were malnourished at admission, and that the risk of subsequent complications was higher in malnourished patients (Naber *et al.*, 1997). This frequency of DRM was as high as or higher than that reported in surgical patients (30%; Naber *et al.*, 1997). This 40% of DRM may be an underestimate, because patients were excluded if nutritional status could not be assessed within 24 h after admission. The consequences of malnutrition, if left untreated, are serious, causing a marked decline in physical and psychological health and function (Stratton and Elia, 2007). Malnutrition impairs recovery from disease and injury (including surgery), increasing mortality and complications (infections, pressure ulcers, etcetera) and healthcare use (general practitioners visits, length of stay (LOS); Martyn *et al.*, 1998). Recently, also a burden of illness study was performed in the Netherlands (Tan and Koopmanschap, 2007). This study reports that the additional costs of DRM in the Netherlands is € 1683 billion in 2006, which equals 2.8% of the total Dutch national health expenditures. The majority (49%) of the total costs on disease-related costs were attributable to the hospital setting (€ 830 million).

Correspondence: K Freijer, Medical Department, Nutricia Advanced Medical Nutrition, on behalf of the Dutch Industry of Children and Dietary Nutrition (VNFKD), Albert Einsteinlaan 20, 2719 EP, Postbus 445, Zoetermeer, 2700 AK, The Netherlands.
E-mail: karen.freyer@nutricia.com
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Meta-analyses on treatment of DRM with medical nutrition show a reduction in mortality and complications, for example, sepsis, decubitus and pneumonia, improvement of wound healing, and an increase of quality of life (http://www.snellerbeter.nl 2008; Elia *et al.*, 2005a ,b; Stratton, 2005). Stratton and Elia concluded that nutritional support can be an important part of the management of any patient (Stratton and Elia, 2007).

The published literature (meta-analyses and systematic reviews) provide evidence that oral nutritional supplements (ONS) are an effective treatment for patients with malnutrition:

Mortality rates are significantly lower (odds ratio of 0.61; 95% CI 0.48–0.78) (Stratton and Elia, 2007). Similar findings were reported in other reviews (Potter, 2001).

Complication rates, including infections, are significantly reduced (odds ratio of 0.31; 95% CI 0.17–0.56; Stratton *et al.*, 2003; Stratton and Elia, 2007). Another systematic review showed that medical nutrition can significantly reduce the risk (25% risk reduction) of developing pressure ulcers (Stratton *et al.*, 2005).

In summary, DRM has a high prevalence and its clinical consequences may be severe and costly. Consequently, inappropriate management of DRM may have a high economic impact.

Study objectives

The primary objective of this study was to assess the cost-effectiveness of ONS, being a medical nutrition product, in patients undergoing abdominal surgery in the Netherlands.

Methods

A model was constructed using decision analytical techniques (Weinstein and Fineberg, 1980). This decision analytical model was developed to estimate the health economic impact of oral ONS in abdominal surgery from the perspective of the society in 2008, in the Netherlands. Data sources used included published literature, clinical trials, and official Dutch price/tariff lists and national population statistics.

Univariate sensitivity analyses are based on the modification of the basic clinical and economic assumptions in the model in order to test the stability of the conclusions of the analysis over a range of assumptions, probability estimates and value judgments.

- Proportion of malnutrition: the base-case analysis (30%) is based on data for abdominal surgery; the range for the sensitivity analysis also includes data for nonsurgical patients. The sensitivity analysis is based on a range varying from 25 to 40%.
- Proportion of eligible patients: the base-case analysis is based on the assumption that all malnourished patients are treated; a sensitivity analysis is based on a proportion of 50% of malnourished patients being treated with ONS.
- Cost of ONS: the cost of ONS is varied between 10% discount of the market price for in-patients (€ 2.19 per bottle) and an outpatient price including VAT (€ 2.37 per bottle).
- Cost of hospitalization: the base-case analysis is based on a weighted per diem cost for academic and general hospitals. A sensitivity analysis is performed varying the *per diem* between the *per diem* of a general hospital (€ 357) and the *per diem* of an academic hospital (€ 504).
- Duration of treatment with ONS: the base-case analysis is based on a mean value of 8.5 days. A sensitivity analysis is performed varying the initiation from 7 to 16 days.
- LOS: a sensitivity analysis is based on a 25% decrease and increase of LOS for all patients (no risk and risk patients). This range was a subjective choice because of lack of data for the construction of a confidence interval. However, a 25% decrease and increase reduction of LOS can be considered a very extreme range, and therefore captures the uncertainty in this input variable. A second sensitivity analysis was performed on a 25% decrease and increase of LOS for risk patients.

Model design

The model calculates and compares the medical costs for a virtual population of abdominal surgery patients with ONS and for a virtual population of abdominal surgery patients without ONS. The health economic impact of ONS is calculated using a decision tree model built in TreeAge Pro 2005/2006 reflecting treatment patterns and outcomes in abdominal surgery. Figure 1 shows the structure of the model for treatment with ONS. The first branch point in a tree is called a decision node because it corresponds to a choice of treatment—ONS or ‘no ONS’. A decision node is represented as a small square (□). Subsequent to the decision node, the structure of the decision tree is shown, which is identical for both treatment options. The other

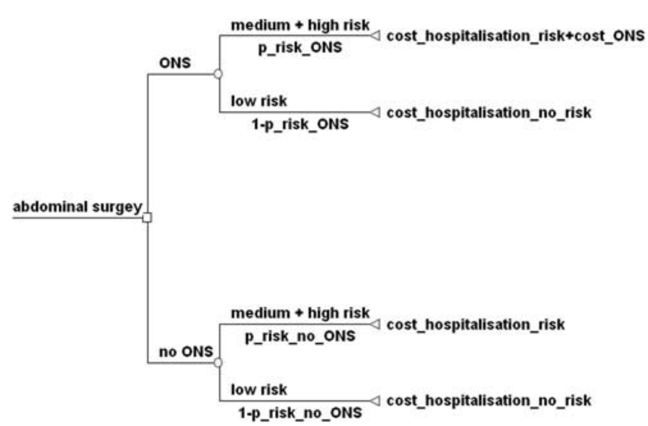

Figure 1 Model for the use of ONS in abdominal surgery.

branch points indicate probabilities. The patient may be at medium to high risk for DRM or at low risk for DRM.

Study population and comparison
The base-case analysis is based on a comparison of the use of ONS versus 'no use' of ONS in patients undergoing abdominal surgery.

Cost assessment
An incremental costing approach was used, and therefore all drug utilization (and other health care utilization) being similar between the two treatment arms was not included in the model. The incremental cost difference was based on the costs associated with the cost of ONS and hospitalization. The model is based on the assumption that the use of ONS only has an impact on the LOS. The potential favourable impact on adverse events by ONS, and therefore the lower costs caused by adverse events were not included in this analysis, because of lack of appropriate data to feed the model. Thus, the costing methodology is based on a conservative approach towards the use of ONS. The real economic benefits will therefore be higher than could be calculated with the current data set (see Discussion). The perspective of the study was a limited societal perspective, because indirect costs were not included. Indirect costs because of productivity loss were not included in this health economic analysis. This is a conservative assumption towards the use of ONS, because the lower LOS would lead to lower productivity loss and therefore lower indirect costs. On the other hand, a substantial proportion of patients undergoing abdominal surgery may be retired, as the average age is 63.2 according to a Dutch study (Kruizenga *et al*., 2003). Discounting of costs and effectiveness measures were not performed, because time horizon of the model did not exceed 1 year.

Data sources
The number of abdominal surgery procedures. A CBO publication reports the annual number of surgery procedures (1.3 million) in the Netherlands (http://www.cbo.nl, 2007). This is an overall number without defining the type of surgical procedure. The annual number of abdominal surgery procedures is 160 283 (Prismant, 2003).

Prevalence of DRM
Several data on prevalence of DRM in the Netherlands have been published: from an overall prevalence of DRM of 25% (Kruizenga and Wierdsma, 2003) to a more group specific amount of 30% in surgical patients and 40% in nonsurgical patients (Naber *et al*., 1997). A recent Dutch study reports a range on prevalence of DRM varying from 25 to 40% in hospitalized patients, including surgical and nonsurgical patients (http://www.snellerbeter.nl 2008). This report also states that only 50% of malnutrition is being diagnosed and treated. The most recent Dutch documentation is based on an annual returning independent measurement of the prevalence of DRM within the Dutch Health Care (Halfens *et al*., 2006; Halfens *et al*., 2007).

The base-case analysis is based on data from this Dutch documentation; the range for the sensitivity analysis also includes data for nonsurgical patients. Therefore, the base-case analysis is based on a prevalence of DRM of 30% with a range varying from 25 to 40%.

The base-case analysis is based on the assumption that all malnourished patients are treated (eligible patients); a sensitivity analysis is based on the data from 'Sneller Beter', which reports that a proportion of 50% of malnourished patients is not treated with an ONS.

This input data for the Dutch model corresponds with the British Association of Parenteral & Enteral Nutrition (BAPEN) study from the UK, although the prevalence of DRM is somewhat lower: 29.3% for patients older than 65 and 20.4% younger than 65 (Elia *et al*., 2005a, b). The UK data show that the difference in proportion of DRM is higher in the older patients (29.3 versus 20.4%). This difference is however <10%, which is much smaller than the range we use for the sensitivity analysis.

LOS
An international observational study, including Dutch centres, evaluated the implementation of an enhanced recovery programme in five European centres and examined the determinants affecting recovery and LOS (Maessen *et al*., 2007). This study showed that the median LOS was 8 days for standard treatment. A multivariate analysis revealed no country specific effect on LOS. Prismant data from 2003 reports an average LOS of 12.9 days in abdominal surgery in the Netherlands (Prismant, 2003). For clinical outcomes, the general rule may be to assume that data are not country-specific (Nuijten, 1998). LOS in a hospital was considered a clinical outcome, which is not country-specific, which was also an essential assumption in the BAPEN report (Elia *et al*., 2005a, b).

Therefore, international data on LOS were used in this analysis for a Dutch health economic evaluation of ONS.

Table 1 shows the data on LOS, which were reported in the BAPEN report (Elia *et al*., 2005a, b), which is based on a 30% increase of LOS resulting from malnutrition.

Table 1 Data on LOS which were reported in the BAPEN report

Age of population (years)	*LOS (days) when risk for DRM*	*LOS (days) when no risk for DRM*
>65	13.981	10.755
<65	5.390	4.146

Abbreviations: DRM, disease-related malnutrition; LOS, length of stay.

The base-case analysis was based on a LOS of 8 days, based on the above mentioned international study, which included Dutch patients, whereas the 30% increase of LOS resulting from malnutrition was derived from the BAPEN report.

Recommended amount of intake of ONS
Typical prescription for ONS is 2 bottles (2×200 ml) per day per patient. The literature describes that 7–10 days before surgery the intake of ONS ought to be started, which may be continued until 7–10 days after surgery (McClave *et al.*, 1999; FSSPEN French Speaking Society for Parenteral & Enteral Nutrition, 1996; ASPEN, 2002). Therefore, the base-case analysis is based on a mean value of 8.5 days before and after surgery.

Costs of treatment
Costs of ONS. The price of a standard bottle is € 2.19, which corresponds with the list price as registered in the Dutch market. The costs for a hospital are lower because of discounts. The costs for a patient at the pharmacy are higher because of VAT. Therefore, the most realistic price for a bottle would be € 2.19.

Costs of hospitalization. The cost of hospitalization was derived from the Dutch Costing Manual (Oostenbrink *et al.*, 2004).

- *Per diem* academic hospital: € 476
- *Per diem* general hospital: € 337
- Distribution: academic hospital 16% and general hospital 84%

The costs were inflated from 2003 to 2008 (http://www.cbs.nl, 2008).

- *Per diem* academic hospital: € 504
- *Per diem* general hospital: € 357

Results

Base-case analysis
The results of the base-case analysis are shown in Table 2. This analysis shows that the use of ONS does not lead to additional costs. In fact, the use of ONS reduces the costs from € 3318 to € 3066, which corresponds with a € 252 (7.6%) cost saving per patient. The additional costs of ONS are more than balanced by a reduction on hospitalization costs. The hospitalization costs reduce from € 3318 to € 3044 per patient, which is a 8.3% cost saving and corresponds with 0.72 days reduction in LOS.

The use of ONS would lead to an annual cost saving of € 40.4 million based on 160 283 abdominal procedures per year.

A scenario analysis was based on LOS of 12.9 days according to Prismant data (Prismant, 2003). In this analysis, the use of ONS reduces the costs from € 5350 to € 4931, which corresponds with a € 419 (7.8%) cost saving per patient.

Sensitivity analysis
The results of the sensitivity analyses are presented in Table 3. These results show that the use of ONS in all sensitivity analyses remains cost saving compared with 'no use' of ONS.

Threshold analysis
Threshold analyses were performed in order to calculate the break even point for LOS and risk reduction at which the total costs for both treatment strategies are equal.

The first threshold analysis was performed on LOS. This analysis shows that the threshold for LOS is only 0.64 days.

Table 2 Results: base-case results and sensitivity analyses

	Range	*ONS*	*No ONS*	*Savings*
Base case		€ 3066	€ 3318	€ 252
Proportion	25%	€ 3063	€ 3318	€ 255
Malnutrition	40%	€ 3074	€ 3318	€ 244
Eligible	50%	€ 3192	€ 3318	€ 126
Price ONS	1.97	€ 3064	€ 3318	€ 254
	2.37	€ 3068	€ 3318	€ 250
Cost hospitalization	357	€ 2878	€ 3113	€ 235
	504	€ 4054	€ 4395	€ 341
Use of ONS before and after operation	7	€ 3063	€ 3318	€ 255
	10	€ 3070	€ 3318	€ 248
Length of stay	−25%	€ 2305	€ 2489	€ 184
All patients	25%	€ 3828	€ 4148	€ 320
Length of stay	−25%	€ 2838	€ 3021	€ 183
Only risk	25%	€ 3295	€ 3615	€ 320
		€ 3066	€ 3318	€ 252

Abbreviation: ONS, oral nutritional supplements.

Table 3 Results of two-way sensitivity analyses

Sens = >	7500	8750	10 000	11 250	12 500	
Risk_LOS_no supply_larger						
15 000	€ 2305	€ 2610	€ 1914	€ 3218	€ 3523	FSMP
	€ 2626	€ 2976	€ 3326	€ 3676	€ 4026	No FSMP
	€ 321	€ 366	€ 1412	€ 458	€ 503	Savings
13 875	€ 2305	€ 2610	€ 2914	€ 3219	€ 3523	FSMP
	€ 2549	€ 2888	€ 3228	€ 3568	€ 3908	No FSMP
	€ 243	€ 278	€ 314	€ 349	€ 385	Savings
12 750	€ 2305	€ 2610	€ 2914	€ 3219	€ 3523	FSMP
	€ 2471	€ 2801	€ 3131	€ 3460	€ 3790	No FSMP
	€ 166	€ 191	€ 217	€ 241	€ 266	Savings
11 625	€ 2305	€ 2610	€ 2914	€ 3219	€ 3523	FSMP
	€ 2394	€ 2714	€ 3033	€ 3352	€ 3671	No FSMP
	€ 89	€ 104	€ 119	€ 133	€ 148	Savings
10 500	€ 2305	€ 2610	€ 2914	€ 3219	€ 3523	FSMP
	€ 2317	€ 2626	€ 2935	€ 3244	€ 3553	No FSMP
	€ 12	€ 16	€ 21	€ 26	€ 30	Savings

Abbreviations: FSMP, Food for Special Medical Purposes; LOS, length of stay; Sens, sensitivity.

This value can be considered an unrealisticac value compared with the actual LOS in the UK. This would mean that even at a LOS of 1 day, the use of ONS is still cost-effective. As abdominal surgery requires at least 2 days of hospitalization, this threshold analysis shows that the cost-effectiveness of ONS does not depend on local Dutch data on LOS. The second threshold analysis was performed on the increase of LOS for patients with malnutrition. This analysis shows that the threshold for the increase of LOS in risk patients is only 2.7%. This value also can be considered unrealistically low compared with the increase of 30% LOS in the UK. Therefore, this threshold analysis shows that the cost-effectiveness of ONS does not depend on local Dutch data on reduction of LOS.

Discussion

An analysis was performed for the use of ONS, being a medical nutrition product, in abdominal surgery in order to assess the health economic impact in the Netherlands. The rational for performing this health economic analysis in abdominal surgery is that this is the most studied indication. The assumption of this study was that there were no clinical differences between the treatment arms, except for LOS. We have shown that the use of ONS is cost-effective, because of the following:

(1) Total costs for treatment with ONS are not higher than a treatment strategy without ONS: the additional costs for ONS are more than balanced by a reduction in hospitalization costs due to a reduction in LOS.
(2) (2) The analysis is based on similar clinical properties for both treatment strategies. However, the use of ONS is associated with a higher effectiveness, as this treatment leads to a reduction of the LOS.

Consequently, the use of ONS yields at least a similar effectiveness without extra costs, and therefore, can be considered cost-effective (position 1 in Figure 2). Even if we assume that there is no gain in effectiveness, the use of ONS remains cost-effective, as similar effectiveness is provided at lower costs. The results of this health economic analysis show that the use of ONS leads to lower treatment costs per patient, and therefore can be considered cost-effective. The assumption for this health economic analysis is that there is no difference in mortality, complications and quality of life between the use of ONS, in this case ONS, versus 'no use' of ONS in patients undergoing abdominal surgery. This is a conservative assumption towards the use of ONS, because meta-analyses show a reduction in mortality, complications and an improvement in quality of life (http://www.snellerbeter.nl 2008; Elia *et al*., 2005a, b; Stratton, 2005). The real economic benefits for the use of ONS are therefore in fact higher than could be calculated with the current data set. A reduction of complications contributes considerably to a reduction in LOS, and therefore would lower the costs. However, we could not use these data in our model because of the fact that these outcomes for the studied patient group were not the primary ones. Indirect costs due to productivity loss were not included in this analysis. This is a conservative assumption towards the use of ONS, because the lower LOS would lead to lower indirect costs. On the other hand, a substantial proportion of patients undergoing abdominal surgery may be retired. We may also expect that the use of ONS in fact leads to cost savings in other health care budgets: fewer complications during hospitalizations will also lead to fewer follow-up costs (readmissions, consultations and medication; Gariballa *et al*., 2006). Therefore, we may conclude that this health economic is based on conservative assumptions for the use of ONS.

Sensitivity analyses were performed on all parameters, including LOS and *per diem* costs. The results showed that the use of ONS in all sensitivity analyses remains cost saving compared with 'no use' of ONS.

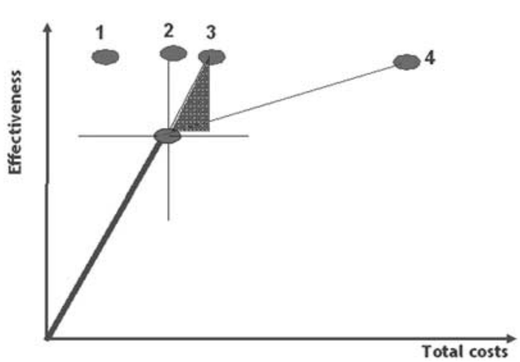

Figure 2 Cost-effectiveness diagram.

Conclusion

We performed a health economic analysis in order to assess the health economic impact of ONS in the Netherlands. This analysis was performed for the use of ONS, being a medical nutrition product, in abdominal surgery and showed that the use of ONS is cost-effective in the Dutch health care setting.

Conflict of interest

The publication of the study results was not contingent on the sponsor's approval; this research was funded by the Dutch Industry of Children and Dietary Nutrition (VNFKD) and Dr Mark Nuijten has served as a consultant and was paid to conduct the analyses presented in this article.

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