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Original article

The costs of disease related malnutrition in hospitalized children☆

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SUMMARY

Introduction: Disease related malnutrition (DRM) is a serious medical condition which is associated with an increase in morbidity and mortality, augmenting resource use and associated costs. DRM can be detected by actively and fully assessing the nutritional status. Studies in adult malnourished patients have shown that the additional health care costs are about € 2 billion (€ 2000 million) per year. The objective of the current study was to estimate the annual additional costs of DRM for pediatric patients as was done for adults.

Methods: A cost-of-illness analysis was performed to calculate the annual additional costs of DRM in 2015 pediatric patients (aged 1 month up to and including 17 years) admitted to non-academic hospitals in The Netherlands. DRM was assessed with weight-for-age, weight-for-height and height-for-age. Input variables in the formula used were length of stay and prevalence of DRM. The costs were estimated per disease as classified in the International Classification of Diseases by the WHO (ICD-10), per gender and age group. The results were expressed as an absolute monetary value as well as a percentage of the Dutch national health expenditure. Robustness of the results was checked by a sensitivity analysis.

Results: The total additional direct medical costs of DRM in pediatric patients in 2013 were estimated to be € 51 million for acute malnutrition, € 46 million when focused on chronic malnutrition and € 80 million in case of overall malnourished children. This equals 5.6% of the total Dutch hospital costs for these hospitalized children.

Conclusions: This study has shown that DRM in hospitalized children is associated with an increase in annual hospital costs with an additional amount of € 80 million, of which acute malnutrition account for the largest part.

1. Introduction

Malnutrition is a continuously huge global problem with substantial clinical as well as economic consequences. Despite the fact that the term malnutrition literally comprises both overnutrition (too many nutrients) and undernutrition (too little nutrients), an etiology-related definition of pediatric malnutrition (undernutrition) has been formulated as follows: an imbalance between nutrient requirements and intake that results in cumulative deficits of energy, protein, or micronutrients that may negatively affect growth, development, and other relevant outcomes [1]. Based on its etiology, malnutrition is either illness related (secondary to one or more diseases/injury), non-illness related (caused by environmental/behavioral factors), or both. For the purposes of this article the term malnutrition is used only for the illness related undernutrition, also known as disease related malnutrition (DRM) as only somatically ill children were included.

Abbreviations: DRM, disease related malnutrition; ICD-10, International Classification of Diseases; RIVM, Dutch National Institute for Public Health and Environment; IGZ, Dutch Health Care Inspectorate.

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Although the criteria for defining malnutrition in pediatric patients are used inconsistently, the WHO cut-off measures of <−2 standard deviation scores for weight and/or height compared to age-adjusted references are the most frequently used [2]. These criteria are based on the fact that growth assessment is the best indicator for the nutritional status of a child, as growth (height and weight) is steadily affected by disruption of health and nutrition irrespective of the cause [3]. International studies have shown a DRM prevalence rate in European hospitalized children from 7% up to 45%, with the highest prevalence rate in children with infections, gastro-intestinal disease, mental and behavioral disorders and those with endocrine, nutritional or metabolic diseases [4–10]. DRM is associated with unfavorable outcomes, including increased rates of infection, increased medical and surgical complications, poor wound healing and increased hospitalization [1,11]. This association with negative clinical consequences has recently been confirmed in a large multicenter prospective European study, showing DRM was associated with an increased occurrence of diarrhea and vomiting, augmented length of hospital stay (LOS) and a decreased quality of life [4]. Studies in adults have shown that DRM is costing the society billions of euros, leading to an estimated annual cost for European governments of up to € 170 billion (€ 120 billion for EU countries) based on a DRM prevalence rate of 33 million patients (about 20 million in EU countries) [12,13]. In children however, there is a lack of data about the additional costs due to malnutrition for hospitalized children in Europe, but it is presumed that costs will be substantial [4].

As no cost-of-illness data for malnourished children in The Netherlands exist, the objective of the current study was to calculate the annual additional costs due to DRM for these pediatric patients as was done for adults [14].

2. Methods

2.1. Cost-of-illness study

A cost-of-illness analysis has been performed similar to the study that estimated the annual additional costs due to malnutrition in adult patients in The Netherlands [14]. Thus, a total cost per patient group was assessed, in which only hospital costs (direct costs) were used due to lack of data on the indirect costs. Direct health care costs include all costs directly related to the use of care, such as prevention, diagnostics, therapy, rehabilitation and care of the considered disease or treatment. Costs related to productivity loss due to absence of work exemplify indirect costs [15].

2.2. Formula and data sources

Our formula that was developed to calculate the additional annual costs due to DRM, reads as follows:

$$(\text{weight factor}-1)^{*}\text{prevalence of malnutrition}^{*}\left[\frac{\text{total disease costs}}{(\text{weight factor}^{*}\text{prevalence of malnutrition})+(1.0^{*}\text{prevalence of } \textit{no} \text{ malnutrition})}\right]$$

With this formula the total additional annual costs per patient group due to DRM in The Netherlands were calculated. For example: total disease costs for the patient group with oncology = 100 million euro and the prevalence of malnutrition within this patient group is 20% (meaning that 20 patients are malnourished and 80 patients are well-nourished). The total oncology costs are then distributed over these 20 and 80 patients. When for example malnourished patients use 40% more health care resources compared to the same patients who are not suffering from DRM, the weight factor will be 1.4 in this formula. The real total costs of managing malnourished as well as well-nourished patients with oncologic disease then corresponds to the factor of $(1.4 \times 20 + 1.0 \times 80) = 108$. Using the complete formula, the total additional costs for the management of the malnourished patients within this patient group oncology is then $(0.4 \times 20 \times (100/108)) = 7.4$ million euro.

Table 1
Weight factor based on the increased Length of Stay (LOS) of malnourished versus well-nourished hospitalized children based on the data provided by the researchers of the Van der Velde study [17].

LOS	DRM	No DRM	Factor
Acute	4.9	3.5	1.39
Chronic	5.1	3.6	1.42
Overall[a]	4.8	3.4	1.40

[a] Overall malnutrition was defined as acute or/and chronic malnutrition.

2.3. "Weight factor" in this study

In this study, the "weight factor" is an impact element that displays the *extra* health care costs in patients suffering from DRM compared to normal-nourished patients. Since LOS is highly correlated to direct health care costs, this was used as proxy to estimate the weight factor [16]. To be accurate in our estimate, the weight factor was based on the recent Dutch multicenter study of Van der Velde et al. [17], that showed a mean 40% increased LOS in the malnourished group compared with similar well-nourished patients (their weight factor is 1), thus resulting in a weight factor of 1.4. After a detailed view and analysis of the full data provided by the researchers of the Van der Velde study, the magnitude of the increase in LOS appeared to be equal for acute and chronic malnutrition (Table 1). Regression analysis on LOS and DRM showed a coefficient of 1.4777 ($p = 0.000$), confirming a significant association of DRM and LOS (malnourished children have a mean 1.5 day longer stay in hospital than children not suffering from DRM).

This increased health care use is in line with the results of an earlier performed study in which 424 children, also aged 1 month up to and including 17 years, admitted to pediatric wards of 44 Dutch hospitals (both academic and non-academic hospitals) were screened for DRM. A multivariate analysis showed that LOS was 45% longer in acutely malnourished patients than in well-nourished patients [18].

2.4. Prevalence of DRM

This cost-of-illness analysis is an estimate of the annual additional direct hospital costs due to DRM for children in The Netherlands, since DRM prevalence data for only hospitalized children in The Netherlands are available. The most recent data were used and obtained from a study, performed in nine non-academic Dutch hospitals in 2013 and 2014, in which the nutritional status from admission to the pediatric hospital ward (including surgical patients) until 4–8 weeks after discharge was