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Original article

Antioxidant intake in paediatric oncology patients

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SUMMARY

Background & aims: Antioxidant intake can affect both free radical and the nutritional status of children receiving cancer treatment. The aim of this study was to investigate whether children with cancer met their antioxidant requirements.

Methods: A prospective observational study was performed at a single hospital in England from June 2008 to February 2010.

Children with a solid tumour, lymphoma or leukaemia were included. Dietary intakes including 3 modes of feeding ('diet alone', 'diet + tube' feeding or 'diet + vitamin-mineral supplementation' (VMS)) were collected with an estimated food record (EFR) 1 and 3 month post-diagnosis. Four and 24-hr food recalls were performed to validate the food records.

Results: Forty two children were included: 57% leukaemia or lymphoma and 43% solid tumours. Sixty seven percent underwent chemotherapy and 33% a combination of therapies. In months 1 and 3, greater numbers of children achieved ≥100% of requirements for 'diet + VMS' ($p < 0.05$) than for other feeding modes. However, considerable proportions of all feeding groups did not achieve 100% of the Recommended Nutrient Intake (RNI) for vitamin A, C, E, selenium and zinc. This was most marked in the 'diet alone' group. Significant proportions did not achieve the Lower Recommended Nutrient Intake (LRNI) for some antioxidants. The 'diet alone' group had the highest proportion not meeting LRNI for vitamin A ($p << 0.001$; 1st month) and zinc ($p < 0.02$; 3rd month).

Conclusion: Inadequate antioxidant intake was observed in a significant proportion of cancer patients when feeding was not augmented in any way. More research is required to determine the clinical implications of these findings.

1. Introduction

The primary outcomes of nutritional support for children undergoing cancer treatment is to ensure continued age appropriate growth and development throughout treatment, hence preventing malnutrition [1]. Cancer, notwithstanding its treatment, is renowned for its high incidence of malnutrition in children (6%–50%) and is highly dependent on the type, stage and location of the tumour [2,3]. Malnourished children are at higher risk of infections, worse outcomes, impaired tolerance to chemotherapy, impaired immune function and the need for more frequent chemotherapy dose adjustments. [3–7] An important component of cancer treatment is the nutritional management which ensures adequate antioxidant intake. Considerable benefits are seen in well nourished patients during cancer treatment [6,8–10]. On the other hand, antioxidants also have the potential to reduce the production of free radicals from anti-cancer therapies which may lead to reduced killing of cancer cells [11]. Oncologists have expressed concerns that the protective mechanism of antioxidants may not differentiate between healthy and cancerous cells and additional supplementation could interfere with the anti-cancer activity of conventional therapies [12]. We therefore are presented with a dilemma; adequate antioxidant intake which is essential for normal cellular homeostasis versus a potential theoretical risk of reducing the effectiveness of anti-cancer therapy with antioxidant supplementation. There is paucity of data in antioxidants treatment and requirements during cancer treatment for children.

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We therefore set out to establish the actual dietary intake of antioxidants (vitamin A, E, C, selenium and zinc) in a paediatric oncology population and compared them to the United Kingdom Department of Health's (DOH UK) antioxidant requirements for healthy children [13].

2. Materials and methods

A prospective observational study was performed at Addenbrookes Hospital, Cambridge University Hospitals NHS Foundation Trust, England from June 2008 to February 2010. Ethical approval was obtained for this study and informed consent was obtained from all participants prior to enrolment in the study. All newly diagnosed children between 1 and 16 years with solid tumours, lymphomas or leukaemia were eligible to be included in the study. Children on home parenteral nutrition receiving breastmilk, and those less than 1 year of age were excluded from the study. Patients were recruited to the study within 1 month post diagnosis. In this same period, patients were assessed by a paediatric oncology dietitian. All the children received the same dietetic assessment and care. Data was collected by means of two dietary tools; a 4-day estimated food record (EFR) over consecutive days (Wednesday to Saturday) and 4 repeated non-consecutive 24-hr recalls in the 1st and 3rd month post diagnosis [14]. As no validated 4-day EFR existed which aimed at establishing antioxidant intake in paediatrics in the United Kingdom (UK), the researcher adapted an existing food record currently used in the Nutrition and Dietetic Department (Cambridge University Hospitals NHS Foundation Trust, UK) to suit the study's requirement. The 24-hr recall method was performed as a secondary dietary intake measurement (test method) to ensure accuracy and reliability of the EFR. EFR's and 24-hr recalls were analysed using the Standard Manual on Food Portions from the Fish and Food Ministry of Agriculture [15].

Anthropometric measurements including weight – [Seca 701 Electronic Personal Scales (GMBH & Co)] and height – Harpenden Stadeometer (Holtain Ltd) and demographic parameters were collected. The weight-for-age z-scores were then assessed against the World Health Organization (WHO) Global Database on Child Growth and Malnutrition [16].

Antioxidant intake (vitamin A, E, C, selenium and zinc) was compared to the RNI, LRNI and Safe Upper Intake commonly used in the UK.

As children with cancer treatment are often reliant on a variety of supplements and often require enteral feeding, nutrition intake was categorised for the purpose of analysis into ‘diet alone’, diet and tube feeds (‘diet + tube’) or diet and vitamin-mineral supplementation (‘diet + VMS’).

3. Statistics

Statistical evaluation was undertaken using SPSS 16 statistical software (SPSS Science, Apache Software Foundation, Chicago, IL, USA) and dietary intake of antioxidants determined using Diet Plan 6.3 programme (Forrestfield Software Limited, Horsham, UK). Non-parametric tests i.e Fishers Exact, and Shapiro–Wilk, bivariate correlation and t - tests were used. A p-value ≤ 0.05 was considered significant. Both the Shapiro–Wilk and Fishers Exact Test was used due to the smaller analysis categories.

4. Results

4.1. Subjects

Fifty two children were recruited into the study, however 10 were excluded due to the following reasons: 4 (8%) withdrew from study; 1 (2%) was not discharged from hospital during treatment; 1 (2%) transferred to an out of area hospital; 4 (8%) consented to study, but did not respond to requests for data. Of the remaining 42 children, 20 were boys (48%) and 22 were girls (52%). The median age was 6 years and 9 months (SD 4.8). Their diagnoses included haematological malignancies (leukaemia; 14 (33%), lymphomas; 10 (24%)) and others (solid tumours; 18 (43%)). Twenty eight (67%) underwent chemotherapy and 14 (33%) a combination of therapies.

Two (5%) and 6 (15%) respectively of children in the 1st and 3rd month were found to be malnourished based on z-scores. In the 1st month, 2 (5%) of children achieved a z-score of <-2 and in the 3rd month, 4 (10%) achieved this score. The mean z-score for the study population calculated at the 1st and 3rd month was −0.22 and −0.34 respectively, indicated that the weight of the population remained relatively the same over this period. There was no statistical difference between the three feeding modes for energy and protein intake.

4.2. Vitamin and/or mineral supplement use

In the 1st month, 8 (27%) of the children consumed vitamin and/or mineral supplements and 4 (18%) in the 3rd month. These supplements were either VS or VMS used in approximately equal proportion at each time point. For the purposes of analysis all were analysed in the ‘diet + VMS’ group.

4.3. Dietary method correlation

Of the 42 children's data analysed, 30 (71%) returned their EFR's in the 1st month's collection of data, however the return rate in the 3rd month was less (n = 22; 52%). The validity of the EFR was established through correlation with the 24-hr recalls for both the 1st and 3rd months (Table 1). There was a strong correlation between the EFR and 24-hr recall at both time points for ‘diet alone’ ($p << 0.001$); the exception being for selenium and zinc at time point 2. For other feeding modes the majority of dietary intakes correlated, however greater day to day variation was seen, in particular in the more complex patients receiving dietary intake and tube feeding. The overall trend however, showed that the children receiving nutritional support showed a higher percentage of RNI antioxidant intake as measured by the EFR method. Underreporting or missing foods is a common limitation of 24-hr recalls, which is related to it's reliance on memory and omissions such as beverages, sauces and supplements are common [17,18]. Several studies in children have found a benefit with using a food diary/

Table 1
Correlation of the Estimated Food Record and 24-hr recall antioxidant intake values for diet alone and antioxidants (1st and 3rd month).

Antioxidants	r – value	p- value
Vitamin A		
EFR 1[a] & 24-hr recall 1	0.70	<<0.001
EFR 2[a] & 24-hr recall 2	0.70	<<0.001
Vitamin C		
EFR 1[a] & 24-hr recall 1	0.56	<<0.001
EFR 2[a] & 24-hr recall 2	0.72	<<0.001
Vitamin E		
EFR 1[a] & 24-hr recall 1	0.54	<<0.001
EFR 2[a] & 24-hr recall 2	0.45	0.05
Selenium		
EFR 1[a] & 24-hr recall 1	0.64	<<0.001
EFR 2[a] & 24-hr recall 2	0.50	0.67
Zinc		
EFR 1[a] & 24-hr recall 1	0.81	<<0.001
EFR 2[a] & 24-hr recall 2	0.38	0.10

[a] EFR = estimated food record.