Nutritional Profile of Children with Brain Tumor with Diencephalic Syndrome or Russell Syndrome receiving Enteral Diet

doi: https://doi.org/10.32635/2176-9745.RBC.2018v64n3.36

Perfil Nutricional de Crianças Portadoras de Tumores Cerebrais com Síndrome Diencefálica ou Síndrome de Russell recebendo Dieta Enteral

Perfil Nutricional de Niños Portadores de Tumores Cerebrales con Síndrome Diencefálico o Síndrome de Russell recibiendo Dieta Enteral

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Abstract

Introduction: Diencephalic syndrome is a rare disorder of infancy characterized by profound emaciation with failure to thrive. The majority of cases of the syndrome are due to low grade gliomas of the anterior hypothalamus or optic nerve. **Objective:** To report the nutritional status and efficacy of nutritional support in patients with brain tumors that developed the Russell's Syndrome. **Method:** Seven patients were retrospectively evaluated by means of z-score of the weight for age (W/A), weight for height (W/H) and height for age (H/A) nutritional status index, for protein-energy malnutrition diagnosis. They were evaluated by means of triceps skinfold thickness (TSFT), arm circumferences (AC) and muscle arm circumferences (MAC) and received enteral nutrition, by nasoenteral tube or gastrostomy at cancer diagnostic. **Results:** The ages ranged from 2 months to 13 years, five children were males. Mean of the nutritional support was 7 months (1.1-18.5 months) after diagnostic, without statistical differences in z-scores evolution, but there are increase in averages of the W/A (-4,42 to -3,50) and W/H (-3,06 to -1,99), and body composition indicators (TSFT): 2.85 to 4.88, AC: 9.81 to 11.84 and MAC: 8.91 to 10.31). There was decreased in average of H/A, evidencing the growth arrest of these children. **Conclusion:** Enteral feeding has been shown to guarantee nutritional supply and to partially recover nutritional indicators of acute malnutrition; especially body fat, rather than lean mass. However, the growth deficit was not corrected, being aggravated in most cases. Nutritional support should be implanted during oncological treatment, ensuring its maintenance.

Key words: Silver-Russell Syndrome; Brain Neoplasms; Enteral Nutrition; Nutrition Therapy; Child.

Resumo

Introdução: A síndrome diencefálica é uma doença pediátrica rara, decorrente de tumores hipotalâmicos, caracterizada por *failure to thrive*. **Objetivo:** Descrever o estado nutricional e a terapia nutricional por meio de sonda nasoenteral de pacientes com tumores cerebrais com a síndrome diencefálica. **Método:** Sete pacientes foram acompanhados de julho/1999 a abril/2002 e analisados retrospectivamente, usando os escores-z de peso para idade (P/I), peso para estatura (P/E) e estatura para idade (E/I) no diagnóstico da desnutrição. Todos foram avaliados por meio de composição corporal: prega cutânea tricipital (PCT) e circunferências do braço e muscular do braço (CB e CMB) e receberam alimentação por sonda nasoenteral ou gastrostomia após o diagnóstico da neoplasia. **Resultados:** A idade variou de 2 meses a 13 anos, cinco do sexo masculino. A duração média da nutrição enteral foi de 7 meses (1,1-18,5) após o diagnóstico, sem diferença estatística significante na evolução dos escores-z, apesar do aumento nas médias de P/I (-4,42 para -3,50) e P/E (-3,06 para -1,99), e dos indicadores de composição corporal (PCT: 2,85 para 4,88; CB: 9,81 para 11,84 e CMB: 8,91 para 10,31). Houve redução na média da E/I, caracterizando o atraso no crescimento dessas crianças. **Conclusão:** A nutrição enteral demonstrou garantir a oferta nutricional e recuperar em parte os indicadores nutricionais de desnutrição aguda; principalmente a gordura corporal, mais do que massa magra. Entretanto, manteve-se o déficit de crescimento, agravado na maioria dos casos. A terapia nutricional deve ser implantada durante o tratamento oncológico, assegurando sua continuidade.

Palavras-chave: Síndrome de Silver-Russell; Neoplasias Encefálicas; Nutrição Enteral; Terapia Nutricional; Criança.

Resumen

Introducción: El síndrome diencefalica es una enfermedad pediátrica rara, derivada de tumores de la región hipotalámica, caracterizada por *failure to thrive*. **Objetivo:** Describir condiciones nutricionales y terapia nutricional de pacientes con tumores cerebrales com síndrome diencefalica y nutrición enteral. **Método:** Siete pacientes fueron acompañados de julio/1999 a abril/2002 y analizados retrospectivamente, usando el score-Z de peso para edad (P/I), peso para estatura (P/E) y estatura para edad (E/I) para el diagnóstico de la desnutrición. Todos fueron evaluados por composición corporal (pliegue cutáneo tricipital y circunferencias del brazo y muscular del brazo). Los pacientes recibieron nutrición enteral por sonda o gastrostomía, luego del diagnóstico de cancer. **Resultados:** La edad varía de 2 meses a 13 años, cinco del sexo masculino. La duración media de la nutrición enteral fue de 7 meses (1,1-18,5) después del diagnóstico. No hubo diferencia estadística en la evolución nutricional, a pesar del aumento en P/I (-4,42 a -3,50) y P/E (-3,06 a -1,99), así como en la composición corporal (PCT: 2,85 a 4,88, CB: 9,81 a 11,84 y CMB: 8,91 para 10.31). Hubo una reducción de E/I, caracterizando el retraso en el crecimiento. **Conclusión:** La nutrición enteral demostró garantizar la oferta nutricional.e la recuperación parcial de la desnutrición aguda, principalmente grasa corporal, más que masa magra, sin respuesta al déficit en el crecimiento, que se agravó en casi todos los casos. La terapia nutricional debe ser implantada durante el tratamiento oncológico, asegurando su continuidad.

Palabras clave: Síndrome de Silver-Russell; Neoplasias Encefálicas; Nutrición Enteral; Terapia Nutricional; Niño.

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INTRODUCTION

Tumors of the central nervous system are solid and are common in the pediatric age bracket, as the second cause of malignant neoplasms in childhood [1]. Of all CNS tumors in pediatric patients, 40-45% are low-grade gliomas, or tumors of the glial cells. Diencephalic syndrome is a rare pediatric neurological disorder, caused by gliomas originating in the anterior hypothalamus or optic chiasm[2]. Alterations can occur in the energy, hormonal, and fluid and electrolyte balance, among others, triggering important nutritional disorders and resulting in failure to thrive, with insufficient growth and abnormal wasting (severe emaciation). Diencephalic syndrome is commonly observed in early childhood, with few reports in older children and adults[3-5].

Emaciation is frequently observed in infants and smaller children with diencephalic syndrome. Decreased appetite, increased energy expenditure, and decreased nutrient absorption are responsible for the nutritional deficit, predisposing to refeeding syndrome[3,4].

When compared to other diagnoses, patients with brain tumors undergoing intensive chemotherapy need nutritional therapy for prolonged periods, preferably enteral nutrition [6,7,8].

Studies assessing new proposals to treat malnutrition in children with cancer are important, given the impact on treatment tolerance, response to chemotherapy, and survival time[9]. Nutritional therapy methods in this group have been discussed in recent years[10]. Cancer patients that benefit from nutritional therapy include children with brain tumors, particularly those with diencephalic syndrome or Russell syndrome.

This study's objective is to describe the evolution in nutritional status and nutritional therapy via enteral nutrition in children with diencephalic syndrome.

METHOD

This is a retrospective case series analysis, with data collected from the clinical and nutritional evolution of seven children with brain tumors who developed diencephalic syndrome, conducted at the Pediatric Oncology Institute / Support Group for Children and Adolescents with Cancer/Federal University of São Paulo (IOP/GRAACC/UNIFESP), Brazil.

Patients were treated and monitored per protocol from July 1999 to April 2002. Data were collected from diagnosis to the last nutritional consultation, documented in each patient's records and electronic spreadsheets. Nutritional follow-up varied according to the proposed oncological treatment and patient's survival.

The sample included all children with brain tumors with diencephalic syndrome with diagnostic confirmation during the follow-up period. Exclusion criteria were children with brain tumors who did not develop diencephalic syndrome.

Z-scores for W/H, W/A, and H/A were applied at diagnosis and at the last assessment and classified according to World Health Organization (WHO)[11] guidelines, which was the methodology used at the time of follow-up. Triceps skinfold thickness (TSFT), arm circumference (AC), and arm muscle circumference (AMC) were obtained at the same time. TSFT was measured with a skinfold caliper (Harpenden/Cescorf model), and AMC was measured at the midpoint between the acromion and the olecranon and calculated by the equation: AMC = MUAC - (TSFT x 0.314). These variables were measured and interpreted according to standards and percentile tables[12].

Feeding was administered via enteral tube or gastrostomy (laparoscopic or surgical) following diagnosis of the neoplasm. Patients received commercial polymeric formulas, and in the case of malabsorption and/or diarrhea during the study, oligomeric formulas (with easy absorption) were offered.

Descriptive analyses of the demographic variables, nutritional status, and nutritional therapy were performed with means and standard deviations.

Wilcoxon rank sum test was used to analyze differences between the nutritional assessments, with significance set at 0.05 or 5%.

The Institutional Review Board of the Paulista School of Medicine of Unifesp approved the study, under protocol number CEP 1792/07 (21/12/2007), guaranteeing the patients' rights to privacy, in compliance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving human subjects.

RESULTS

Age ranged from two months to 13 years. Seven patients were treated, five of whom were males. Mean duration of nutritional therapy was 6.9 months (median 2.8 months; 1.1-18.5) after diagnosis. One patient (number 6) remained in follow-up after relapse of the tumor. Five patients required oligomeric diets from the beginning.

Five children received chemotherapy, and six underwent surgery. No gastrointestinal or infectious complications were observed in association with the enteral nutrition. Six patients evolved to death, three of whom due to post-operative complications related to the cancer treatment and three from progression of the

disease, diagnosed after the last nutritional assessment in the course of treatment.

As for growth, four children presented severe height deficit and two had moderate height deficit at diagnosis. After nutritional therapy, six presented height deficits, five of which were severe and one was moderate. Of the six children with height impairment, only one had not become worse, and only one child did not present height deficit during treatment.

As for weight, three children initially presented moderate weight deficit, four were severe, and at the end one was moderately malnourished and four were severely malnourished. The mean z-scores for weight increased from the first to the last assessment (W/A = -4.42 to -3.50; W/H = -3.06 to -1.99), but without a significant difference between the periods (Table 1). The mean fat mass and lean mass values increased (Table 2), but also without reaching significant differences.

Duration of nutritional therapy varied between patients, lasting from 26 days to 18.5 months, as shown in Table 1. Total parenteral nutrition was not administered as adjuvant therapy to recover nutritional status, nor did gastrointestinal complications require total parenteral nutrition. Patients 4, 5, and 7 were unable to undergo more prolonged nutritional therapy, due to early death in the post-operative period.

DISCUSSION

The gold standard for treatment of low-grade gliomas in pediatric patients is complete surgical resection, associated with longer disease-free survival in children.

Table 1. Description of seven patients according to anthropometric variables (mean and standard deviation) before and after intervention with enteral tube or gastrostomy at IOP/Graacc/Unifesp

W	NS	Age months	NS	Wi	Wf	Hi	Hf	zW/A i	zW/A f	zH/A i	zH/IA f	zW/H i	zW/H f	NSt i	NSt f
1	NET/NGT/GT	6.39	18.5	4.79	10.14	62	78	-3.13	-1.90	-2.17	-3.08	-2.15	-0.45	MHD/ MWD	SHD
2	NET/GT	24.03	13.9	7.08	13.8	74	79.8	-4.10	-0.52	-3.48	-4.25	-2.39	2.33	SHD/ MWD	SHD/ MWD
3	NET/NGT	10.32	9.6	4.00	6.43	62.5	72	-5.65	-4.33	-4.21	-3.65	-3.51	-3.44	SHD/ SWD	SHD/ SWD
4	NGT	8	1.6	3.00	3.08	57.3	58.4	-5.99	-6.29	-5.15	-5.27	-3.23	-3.46	SHD/ SWD	SHD/ SWD
5	NGT/NET	10.81	1.1	4.17	4.28	63	63	-4.96	-5.01	-3.60	-3.99	-3.29	-3.12	SHD/ SWD	SHD/ SWD
6	NGT/ PO	163	2.8	17.3	19.0	136.5	137	-4.03	-3.93	-2.80	-2.92	-4.75	-4.25	MHD/ SWD	MHD/ SWD
7	NGT/NET	4.68	1.8	5.00	5.99	63	65	-3.11	-2.53	-1.77	-1.66	-2.11	-1.51	MWD	noHWD
M		32.46	6.9					-4.42	-3.50	-3.31	-3.55	-3.06	-1.99	-	-
SD		57.91						1.15	1.97	1.17	1.14	0.94	2.31	-	-
Statistical analysis		Wilcoxon test						*p=0.09 NS*		*p=0,18 NS*		*p=0,06 NS*			

Key: W = weight; i = initial; f: final; NS (in months): nutritional support; NS: time or period of nutritional support; NGT: nasogastric tube; NET: nasoenteral tube; GT- gastrostomy; PO - oral NSt: nutritional status; MHD: moderate height deficit; SHD: severe height deficit; MWD: moderate weight deficit; SWD: severe weight deficit; noHWD: no moderate or severe deficit according to z-scores for W/H and H/A; M = mean; SD = standard deviation; NS = non-significant.

Table 2. Description of seven patients according to body composition variables (mean and standard deviation) before and after intervention with tube or gastrostomy feeding at IOP/Graacc/Unifesp

Patient		TSF i	TSF f	AC i	AC f	AMC i	AMC f	TNS
1		3.36	11.30	11.10	16.60	10.04	13.05	18.49
2		4.30	9.80	11.00	16.50	9.63	13.42	13.96
3		1.93	4.70	7.80	11.50	7.19	10.02	9.63
4		2.56	2.33	7.50	7.20	6.69	6.46	1.60
5		1.53	1.70	7.30	7.60	6.81	7.06	1.08
6		2.86	1.60	13.50	13.00	12.60	12.49	2.81
7		3.40	2.70	10.50	10.50	9.43	9.66	0.85
Mean		2.85	4.88	9.81	11.84	8.91	10.31	6.92
Standard deviation		0.94	4.03	2.34	3.81	2.16	2.82	7.15
Median		2.86	2.70	10.5	11.50	9.43	10.02	2.81
Statistical analysis	Wilcoxon test	*p=0.4 NS*		*p=0,13 NS*		*p=0,08 NS*		

Key: i = initial; f: final; TNS: time on nutritional support in months; TSF (mm): triceps skinfold; AC (cm): arm circumference; AMC (cm): arm muscle circumference; NS = non- significant.

However, when the glioma cannot be totally resected, treatment is limited to radiotherapy or chemotherapy. Due to the high disease progression rates in children with inoperable low-grade gliomas, many are subject to prolonged clinical treatment. Radiotherapy results in objective tumor shrinkage in some patients and can improve progression-free survival in children with partially resected tumors, but many children with low-grade hypothalamic/chiasmatic gliomas are very young, and these gliomas are usually very extensive. Radiotherapy in these circumstances can cause significant neurological/cognitive sequelae, while very small children with low-grade glioma show very poor survival. BRAF-mutated tumors present weak response to traditional chemotherapy and unfavorable prognosis. In pediatric low-grade glioma, a BRAFV600E mutation was identified, and thus targeted therapy has been investigated, with success in some cases. This condition has led medical teams to view low-grade glioma as a chronic disease, basing the treatment on a balance between the benefits and the morbidity and mortality associated with it[13].

Children with diencephalic syndrome are prone to severe nutritional deficit at diagnosis of the neoplasm, with resulting failure to thrive, as observed in this study. Loss of subcutaneous fat is common, with severe emaciation and arrested growth, as seen in these patients. As discussed, weight loss or difficulty in gaining weight can occur be due to decreased appetite and hypermetabolism. Metabolic disorders and complications from the therapeutic procedures also hinder nutritional intervention[3].

The treatment protocol for children under five years with diencephalic syndrome is chemotherapy and surgery, mainly for tumor decompression[5]. However, surgery is an extremely aggressive procedure, especially in the presence of severe malnutrition. Thus, before submitting children to aggressive surgery, it is essential to treat their nutritional deficit, given the negative impact of malnutrition on the perioperative response[14]. In the current study, three children (4, 5, and 7) submitted to surgery right after diagnosis presented severely compromised nutritional status and did not survive.

Nutritional therapy should take into account the gastrointestinal toxicities resulting from chemotherapy, which contribute to malnutrition, although to lesser degrees in these cases. The most common adverse effects are nausea, vomiting, and constipation due to the types of drugs used[15].

In the current study, due to the degree of malnutrition, low acceptance of oral diet, and sequelae from the disease and treatment, the chosen feeding routes were enteral tube and gastrostomy. Nutritional therapy is part of the treatment plan in these cases, aimed at maintaining patients for a prolonged period on chemotherapy. Efficient nutritional therapy guarantees the recovery and maintenance of adequate nutritional status and thus effective antineoplastic treatment.

Although nutritional therapy is essential, its implementation requires attention to the risks of refeeding syndrome, due to the severity of malnutrition and emaciation in these children. The main manifestations are fluid disorder, thiamine deficiency, hypophosphatemia, hypomagnesemia, hypokalemia, and abnormalities of glucose metabolism [16]. Its prevention is based on correction of the fluid and electrolyte disorders and multiple vitamin and mineral deficiencies before initiating nutritional therapy, to be implemented initially with 50% of the energy needs, stepping up gradually[17].

Enteral nutrition is a well-established approach in pediatric cancer patients with some degree of nutritional risk or malnutrition, since its use is associated with recovery of nutritional status in this patient population. However, clinical trials are still needed, assessing its benefits in the treatment response, incidence of complications, and prognosis[18-21,2,22,23].

Of the seven patients in this study, three received nutritional therapy for less than two months (due to death in the post-operative period) and had more complications associated with the disease, which compromised the full nutritional supply. The short period of nutritional therapy and the clinical complications probably comprised the patients' nutritional evolution.

Although there was no statistically significant difference in the patients' nutritional status, the four children that received nutritional therapy for more than two months showed improvement in their nutritional indicators.

We found no studies on nutritional therapy in pediatric patients with brain tumors that developed diencephalic syndrome. Some evidence shows that malignant cells from the glioma depend critically on glucose as their principal source of energy to survive and sustain their aggressive properties. Like most cancers, glioblastomas generally have deregulated mitochondria, impairing the efficiency of the tricarboxylic acid cycle and oxidative phosphorylation activity, necessary for aerobic energy production. Most tumor cells depend on the generation of energy through the comparatively inefficient anaerobic glycolysis pathway. Various important genetic alterations found in high-grade gliomas relate energy metabolism to cancer[24]. Growing knowledge on molecular and genetic aberrations in these tumors suggests a series of new nutritional strategies, but the nutritional therapies proposed thus far show limited success. There existing evidence is still largely inconclusive, partly due to the molecular heterogeneity of these tumors.

Ketogenic diet has been tested for patients with brain tumors, but it still requires further studies[25].

Thus, conventional nutritional therapy is still the standard approach. In general, studies in malnourished children with cancer that received nutritional therapy via enteral tube and gastrostomy with hypercaloric and hyperproteic diets present positive results in the recovery of nutritional status. Nevertheless, some authors report the need for adjuvant parenteral nutrition together with enteral nutrition[7, 8,26.]

Parenteral nutrition was not used in this study, even as adjuvant nutritional therapy for nutritional recover. This modality, as an adjuvant to enteral nutrition, was not part of the treatment plan in this study, since its use is reserved for the most severe cases in which feeding by the gastrointestinal tract is contraindicated or compromised by severe gastrointestinal toxicity. In addition, the absence of a protocol for total parenteral nutrition in the outpatient setting also ruled out its introduction. Nevertheless, in cases in which enteral nutrition was not capable of meeting the patient's needs, combined parenteral nutrition could improve the results in nutritional status.

Alternative methods have been proposed for children with cancer that require prolonged nutritional therapy. In recent years, feeding via gastrostomy has been replacing enteral tube feeding due to the advantages in prolonged use. In addition to other aspects, it presents better ease of handling by professionals, patients, and families, and is aesthetically more acceptable and involves fewer inconveniences during chemotherapy, given the losses and reintroductions of enteral tubes because of vomiting.

The results of a retrospective study by Mathew *et al.* at St. Jude Children's Research Hospital confirm the data on the use of gastrostomy for prolonged feeding periods in children with cancer, without severe complications or post-operative mortality associated with the procedure[27]. Other authors have demonstrated the efficacy of endoscopic or percutaneous radiological gastrostomy in nutritional maintenance or recovery, feasible in pediatric cancer patients with low rates of severe complications. However, the technique via open surgery presents more complications[28-30].

In the current study, height deficit became more severe over the course of follow-up. Although all the indicators of body composition increased after nutritional therapy, regardless of the type of device (enteral tube or gastrostomy), there was a recovery of nutritional status via weight gain, but without an improvement in height. These unfavorable results for height (Table 1) characterize arrested growth and are typical of this patient group. This factor is probably associated with the chronicity of the disease, which increases muscle catabolism. Nutritional therapy is thus not capable of modifying this profile in this early phase. However, even the patients that received longer nutritional therapy (> 12 months in two children) presented a height deficit. A limiting factor for the study was its retrospective design, with variable duration of nutritional therapy between patients (mean 7 months; median 2.8 months). Considering complications from the disease and treatment, these children require a prolonged period of nutritional recovery. However, it is not known if the deficit would be greater if nutritional therapy were not implemented. Short periods of nutritional support do not allow meeting nutritional needs, which interferes in growth and development[31]. Besides, since the disease is severe and the proposed treatment is long-term, nutritional therapy is a basic condition for greater success with the treatment plan.

The study's results were similar to those of Skolin *et al.*[29], who observed delayed linear growth in children with cancer after a year of nutritional therapy, which according to the authors could be associated with disease severity.

Three of the seven children in the study corrected their severe weight deficit, one reaching normal weight and the other two evolving to overweight and mild malnutrition, respectively. The evolution in the means shows that the recovery of W/H was the most important (-3.06 to -1.99; p=0.06). The two children that used gastrostomy (patients 1 and 2) were the ones with diagnosis of normal weight and overweight, a result that was probably associated with longer time on nutritional therapy (Table 1).

Excess weight gain in the long term, mainly characterized by the increase in adipose tissue, is a common risk factor in children with brain tumors when the disease becomes chronic. Indicators of adiposity (TSF) and muscle tissue (AMC) showed similar evolution (Table 2) and accompanied the results of the weight indicator, although without showing statistically significant differences.

Although the small sample size did not allow identifying statistically significant differences, the individual results illustrate the importance of nutritional therapy for patients with diencephalic syndrome, and that it is essential for at least partially recovering the nutritional status in these children. Meanwhile, impaired growth and development and the risk of fat accumulation are important sequelae during long-term follow-up.

Antineoplastic treatment is performed with prolonged chemotherapy to allow later surgical intervention with greater odds of success and lower risk of complications, which also requires prolonged nutritional support.

CONCLUSION

Children with diencephalic syndrome should be treated as chronic patients for whom the treatment plan should be

implemented with caution, drawing on multidisciplinary care to reduce morbidity and mortality. Severe malnutrition is one of the initial characteristics of diencephalic syndrome, making treatment of the disease an even greater challenge for the attending team. Nutritional therapy allowed partial recovery of nutritional status, mainly with more prolonged use. Percutaneous gastrostomy can be a more efficient method for guaranteeing energy and nutrient supply and ensuring treatment for longer periods, increasing the opportunity for nutritional recovery and success in the antineoplastic response[32].

Adjustments to the nutritional supply should be made over the course of follow-up, with measures taken to prevent sequelae in growth and development and the risk of excessive increase in adipose tissue in the long term.

CONTRIBUTIONS

The authors contributed equally to all stages of the manuscript.

CONFLICT OF INTEREST

None.

FUNDING SOURCES

None.

REFERENCES

1. Instituto Nacional de Câncer José Alencar Gomes da Silva. Estimativa 2018: incidência de câncer no Brasil. Rio de Janeiro: INCA; 2017.
2. Groupman AL, Packer RJ, Nicholson HS, Vezina LG, Jakacki R, Geyer R, et al. Treatment of diencephalic syndrome with chemotherapy. Cancer. 1998 Jul 83;(1):166-172.
3. Waga S, Shimizu T, Sakakura M. Diencephalic syndrome of emaciation (Russell's syndrome). Surg Neurol. 1982 Feb;17(2):141-146.
4. Espiner E, Donaldson I, Chapman B, Bergeron C. Diencephalic idiopathic gliosis: an unusual hypothalamic syndrome of dermopathy, diarrhea and growth arrest. J Endocrinol Invest. 1992 Sep;15(8):609-616.
5. West GA, Berger MS, Geyer JR. Childhood optic pathway tumors associated with ascites following ventriculoperitoneal shunt placement. (case report) Pediatr Neurosurg 1994 Mar;21(4):254-259; discussion 259.
6. Tyc VL, Vallelunga L, Mahoney S, Smith BF, Mulhern RK. Nutritional and treatment-related characteristics of pediatric oncology patients referred or not referred for nutritional support. Med Pediatr Oncol. 1995 Nov;25(5):379-388.
7. Sanchez MC, Iraola GA, Gutierrez NA, Altuna MS, Regato JLB. Estudio nutricional en niños oncológicos. An Esp Pediatr. 1992;36(4):277-280.
8. Pietsch JB, Ford CR, Whitlock JA. Nasogastric tube feeding in children with high-risk cancer: a pilot study. J Pediatr Hematol Oncol. 1999 Mar-Apr;21(2):111-114.
9. Pribnow AK, Ortiz R, Báez LF, Mendieta, L, Luna-Fineman S. Effects of malnutrition on treatment-related morbidity and survival of children with cancer in Nicaragua. Pediatr Blood Cancer 2017 Nov;64(11). doi:10.1002/pbc.26590. Epub 2017 Apr 27.
10. Steele C, Salazar A, Rypkema L. Utilization of a nutrition support algorithm reduces unnecessary parenteral nutrition use in pediatric oncology inpatients. J Acad Nutr Diet 2016 Aug;116(8):1235-128. doi:10.1016/j.jand.2015.12.007. Epub 2016 Jan 28.
11. Management of severe malnutrition: a manual for physicians and other senior health workers. World Health Organization: Geneva; 1999.
12. Frisancho AR. Anthropometric standards for the assessment of growth and nutritional status. 4th Ed. Ann Arbor: University of Michigan Press; 1993.
13. Martins AR. Terapêutica dos Gliomas de Baixo Grau em Idade Pediátrica [thesis]. Lisboa. Clínica Universitária de Neurocirurgia, Faculdade de Medicina, Universidade de Lisboa; 2017.
14. Windsor JA, Graham LH. Weight loss with physiologic impairment: a basic indicator of surgical risk. Ann Surg 1988 Mar; 207(3):290-296.
15. Nurgali K, Jagoe RT, Abalo R. Editorial: adverse effects of cancer chemotherapy: anything new to improve tolerance and reduce sequelae? Front Pharmacol. 2018 Mar 22;9:245. doi: 10.3389/fphar.2018.00245.
16. Crook MA, Hally V, Panteli JV. The importance of the refeeding syndrome. Nutrition. 2001 Jul-Aug;17(7-8):632-637.
17. Afzal NA, Addai S, Fagbemi A, Murch S, Thomson M, Heuschkel R. Refeeding syndrome with enteral nutrition in children: a case report, literature review and clinical guidelines. Clin Nutr 2002 Dec;21(6):515-520.
18. Bowman LC, Williams R, Sanders M, Ringwald-Smith K, Baker D, Gajjar A. Algorithm for nutritional support: experience of the metabolic and infusion support service of St. Jude Children's Research Hospital. Int J Cancer. 1998;78(11 Suppl):76–80.
19. Pencharz PB. Aggressive oral, enteral or parenteral nutrition: prescriptive decisions in children with cancer. Int J Cancer. 1998;78(11 Suppl):73-75.
20. den Broeder E, Lippens RJ, van't Hof MA, Tolboom JJ, Sengers RC, van den Berg AM, et al. Nasogastric tube feeding in children with cancer: the effect of two different formulas on weight, body composition, and serum protein concentrations. JPEN J Parenter Enteral Nutr 2000 Nov;24(6):351-360.

21. Heubi JE. Whenever possible, use the gut! J Pediatr Hematol Oncol 1999 Mar-Apr; 21(2):88-90.

22. Hastings Y, White M, Young J. Enteral nutrition and bone marrow transplantation. J Pediatr Oncol Nurs 2006 Mar-Apr;23(2):103-110.

23. Broeder E, Lippens RJJ, Van't Hof MA, Tolboom J. Effects of naso-gastric tube feeding, on the nutritional status of children with cancer. Eur J Clin Nutr 1998 Jun;52(7):494-500.

24. Woolf EC, Syed N, Scheck AC. Tumor metabolism, the ketogenic diet and β-Hydroxybutyrate: novel approaches to adjuvant brain tumor therapy. Front Mol Neurosci. 2016 Nov 16;9:122. doi:https://doi.org/10.3389/fnmol.2016.00122.

25. Winter SF, Loebel F, Dietrich J. Role of ketogenic metabolic therapy in malignant glioma: a systematic review. Crit Rev Oncol Hematol. 2017 Apr;112:41-58. doi:https://doi.org/10.1016/j.critrevonc.2017.02.016.

26. Deswarte-Wallace J, Firouzbakhsh S, Finklestein JZ. Using research to change practice: enteral feedings for pediatric oncology patients. J Pediatr Oncol Nurs. 2001 Sep 1;18(5):217-223.

27. Mathew P, Bowman L, Williams R, Jones D, Rao B, Schropp K, et al. Complications and effectiveness of gastrostomy feedings in pediatric cancer patients. J Pediatr Hematol Oncol. 1996 Feb;18(1):81-85.

28. Barron MA, Duncan DS, Green GJ, Modrusan D, Connolly B, Chait P, et al. Efficacy and safety of radiologically placed gastrostomy tubes in paediatric haematology/oncology patients. Med Pediatr Oncol 2000 Mar;34(3):177-182.

29. Skolin I, Hernell O, Larsson MV, Wahlgren C, Wahlin YB. Percutaneous endoscopic gastrostomy in children with malignant disease. J Pediatr Oncol Nurs 2002 Sep 1;19(5):154-163.

30. Fernandez-Pineda I, Sandoval JA, Jones RM, Boateng N, Wu J, Rao BN, et al. Gastrostomy complications in pediatric cancer patients: a retrospective single-institution review. Pediatr Blood Cancer. 2016 Jul;63(7):1250-1253. doi: 10.1002/pbc.25968. Epub 2016 Mar 9.

31. Garófolo A, Maia PS, Petrilli AS, Ancona-Lopez F. Resultados da implantação de um algoritmo para terapia nutricional enteral em crianças e adolescentes com câncer. Rev. Nutr 2010 Set-Out;23(5):715-730.

32. Pederson AM, Kok K, Petersen G, Nielsen OH, Michaelsen KF, Schimiegelow K. Percutaneous endoscopic gastrostomy in children with cancer. Acta Paediatr 1999 Aug;88(8):849-852.

Recebido em 30/8/2018
Aprovado em 8/1/2019