

Nutritional Issues in Adolescents After Bone Marrow Transplant: A Literature Review

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Bone marrow transplantation and related complications can cause gastrointestinal (GI) side effects that can lead to poor nutrition, which has been associated with several morbidity and mortality issues. Adolescents require adequate nutrition not only to maintain health but to advance with normal growth and development. This article synthesizes the bone marrow transplant (BMT) literature regarding adolescents' nutritional needs, etiologies of altered oral intake, GI symptoms, nutritional assessments, nutritional interventions, and quality of life associated with poor nutrition. In addition, gaps in knowledge in the literature are identified. To provide effective and thorough care to patients during their BMT recovery, the knowledge base of nutritional and eating issues after transplant needs to become more comprehensive. Nurses play an important role in gathering and reporting clinical information. By anticipating potential risk factors, assessing and identifying symptoms, and initiating appropriate interventions promptly, patients can experience a more positive BMT experience.

Key words: nutrition, gastrointestinal, eating, bone marrow transplant, pediatric

Bone marrow transplant (BMT) is a common treatment option for adolescents with various malignant and nonmalignant diseases; however,

significant side effects are often experienced as a result of the aggressive treatment. The high-dose chemotherapy and radiation therapy that is required before transplant and complications after the transplant can cause multiple, frequent, and severe gastrointestinal (GI) issues that often lead to poor oral intake requiring interventions to maintain adequate nutrition. The GI issues that affect patients and interventions to support the nutritional status during BMT hospitalization have been documented in the literature; however, there is little recognition of long-term GI issues and necessary support. Ensuring adequate nourishment throughout the BMT process is extremely important for adolescents, who require good nutrition to maintain health and to achieve normal growth and development. In addition, persistent symptoms after treatment have been shown to affect adolescent oncology patients' quality of life; however, no research has evaluated this phenomenon in BMT patients. This literature review will discuss the nutritional needs of adolescents, etiologies of altered oral intake after BMT, common GI symptoms after BMT, eating recovery after BMT, complications associated with poor oral intake, quality of life issues related to poor oral intake, nutritional assessments, symptom assessments, and nutritional interventions.

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A literature search of nutritional issues, GI side effects, and eating experiences in BMT or stem cell transplant patients was conducted using electronic bibliographic databases and hand searching articles for relevant information. Keyword searches included the terms *eating, nutrition, symptoms, gastrointestinal, outpatient, and bone marrow transplant or stem cell transplant*. Initially, the keywords *pediatric or adolescent* were used; however, there were minimal returns using those terms, so they were eliminated, and all age ranges were evaluated in the search. Databases used in the search included MEDLINE, CINAHL, PsycINFO, Sociological Abstracts, Cochrane Database, Web of Science, and Dissertation Abstracts. Articles were considered relevant if they contained any information regarding nutrition, GI symptom(s), or eating experiences in children, adolescents, or adults who had been treated with chemotherapy, BMT, or stem cell transplant. No year limit was placed on the searches; however, the majority of relevant articles were published in the 1990s or 2000s, with only 3 articles published in the 1980s. This may be due to the fact that BMT is constantly evolving and older information is often not relevant to current issues and practice.

The search yielded 68 related articles, which were reviewed and then reduced to 42 relevant articles that were used in the following literature review. The majority of these 42 articles are review articles, with a limited number of research articles. The research articles that were relevant to this topic primarily consisted of nonexperimental studies. The only pediatric, qualitative research articles related to the symptom experience consisted of children undergoing chemotherapy for treatment of cancer; no qualitative studies concerning nutrition, eating, or symptom experiences exist within the BMT literature.

Nutritional Overview

Advances in growth and development occur throughout childhood, but this is more notable during adolescence; 20% of a person's final height and 50% of a person's final weight is obtained during adolescence (Blecker, Mehta, Davis, Sothern, & Suskind, 2000). In addition to linear growth, adolescents experience considerable brain growth and sexual development during this time (Saewyc, 2007). To achieve these growth and development milestones, adequate nutrition is required. In general, healthy adolescent

girls require approximately 2500 kcal every day, and healthy adolescent boys require approximately 3000 kcal daily (Blecker et al., 2000).

Chronically ill adolescents have additional caloric needs to meet the needs for tissue repair and muscle loss that can commonly occur from disease or treatment (Engelking & Rust, 1997). Nutritional needs are increased after BMT to assist with bone marrow engraftment and to overcome BMT complications such as graft-versus-host disease and infection. BMT patients typically require 130% to 150% of normal energy requirements (Herrmann & Petruska, 1993). This means that adolescent girls require approximately 3250 to 3750 kcal per day and adolescent boys require approximately 3900 to 4500 kcal per day during BMT recovery. This additional caloric intake is often difficult for any chronically ill person to maintain because of malabsorption issues, poor appetites, and other GI issues arising from their disease or treatment. The result of malnutrition in chronically ill adolescents can lead to serious deficits in growth and development, poor disease outcomes, increased morbidity, and decreased quality of life (Han-Markey, 2000).

Etiologies of Altered Oral Intake

Patients undergoing BMT have many insults that can significantly affect their ability to eat and absorb nutrients. These events can occur during the initial BMT phase or at any point during BMT recovery. Table 1 summarizes the majority of issues documented in the literature. This information was exclusively documented in review articles; research articles are significantly lacking in this area.

Gastrointestinal Symptoms

There are multiple GI symptoms related to BMT that have been documented in the literature, with the majority of the information again existing as review articles. The articles list nausea, vomiting, diarrhea, oropharyngeal mucositis, esophagitis, anorexia, xerostomia, and dysgeusia as common GI symptoms after BMT (Grant & Kravits, 2000; Sigley, 1998). Only 6 articles detailed research related to GI symptoms post-BMT, and all these studies were nonexperimental in nature. Three of the studies focused solely on taste alterations after BMT, whereas the other 3 studies

Table 1. Etiologies of Altered Oral Intake

Event	Insult	Clinical Manifestation	Literature Source
Treatment: high dose chemotherapy and total radiation	Damage to the GI mucosal cells	Mucositis, esophagitis, nausea, vomiting, abdominal pain, diarrhea	Nitenberg and Raynard (2000)
	Salivary gland damage and decreased saliva production	Taste changes, inability to chew, and/or inability to swallow	Epstein et al. (2002)
	Altered taste and smell	Decreased interest in eating, poor oral intake	Boock and Reddick (1991)
Infection: bacterial, fungal, or viral	GI mucosa damage and/or irritation	Mucositis, esophagitis, nausea, vomiting, abdominal pain, diarrhea	Barker, Anderson, Sauve, and Butzner (2005)
Medications: antibiotics or narcotics	Irritation to the GI tract and electrolyte imbalances	Anorexia, nausea, vomiting, constipation, diarrhea, dry mouth	Cunningham et al. (1983)
Graft-versus-host disease	Damage to the intestinal mucosa	Significant amounts of diarrhea, abdominal pain, anorexia, nausea, vomiting	Keenan (1989)
Psychological influences	Fatigue: no energy to prepare or continue eating a meal	Minimal oral intake or skipped meals	Grant and Kravits (2000)
	Depression: appetite suppression or decreased energy levels	Unable to shop, prepare food, and/or eat	Rust, Simpson, and Lister (2000)
	Anxiety: increased fear of vomiting	Refusal to attempt to eat, even if hunger is present	Rust et al. (2000)
	Food aversion: negative experience when eating	Refusal to attempt to eat, even if hunger is present	Grant and Kravits (2000)
	Stress: increased gastric motility	Abdominal pain, cramping, diarrhea	Grant and Kravits (2000)
Social issues	Change in caregiver or environment; BMT diet: affects how food is prepared	Changes in food taste or food presentation, refusal to eat	Grant and Kravits (2000), Keenan (1989)
	Control: food/eating may be used as a form of choice	Refusal to eat, even if hunger is present	Han-Markey (2000)

NOTE: GI, gastrointestinal; BMT, bone marrow transplant.

evaluated the frequency and longevity of GI symptoms after BMT. Table 2 describes the 6 research studies.

The taste alteration studies were performed only in adults, with 2 of the studies conducted during the acute recovery phase, and 1 study occurring on a long-term basis. The study by Epstein et al. (2002) involved the use of a questionnaire, whereas the studies by Boock and Reddick (1991) and Mattson et al. (1992) involved actual taste tests. This may explain the differing results obtained by these researchers. Epstein et al. (2002) reported no significant change in sweet or salt taste at 100 days post-BMT; however, their sample may not have been able to recall specific taste changes. All 3 study samples were small, and it may be difficult to generalize their findings to other adult BMT patients. Taste sensitivity needs to be evaluated in pediatric patients post-BMT to assess if taste changes are similar to that found in adults. In

addition, taste alterations need to be evaluated in relation to eating in patients recovering from BMT.

The frequency and longevity of GI symptoms were evaluated in 3 studies using pediatric and adult BMT populations through the first year post-BMT. Multiple GI symptoms were present and were considered severe during the acute BMT recovery phase. GI symptoms were often still present at 1 year after BMT but were less frequent. The adult study by Iestra et al. (2002) found tiredness, anorexia, taste changes, dry mouth, and nausea to be common symptoms during the acute BMT recovery phase, which differed from the GI symptoms that were reported in the pediatric study performed by Barker et al. (2005), where mucositis, vomiting, and abdominal pain were reported as common symptoms during the acute phase. This shows the need for more studies to be conducted to verify these pediatric findings and assess the potential

Table 2. Research Studies Related to GI Symptoms Post-BMT

Issue	Author/Year	Sample/Time	Design	Findings
Taste changes	Epstein et al. (2002)	50 adult patients at 100 days post-BMT	Nonexperimental: survey	<ul style="list-style-type: none"> • Bitter and sour tastes more affected than sweet and salty
	Boock and Reddick (1991)	14 adult BMT patients at 3 days and 28 days post-BMT	Nonexperimental: descriptive, repeated measures	<ul style="list-style-type: none"> • No change in bitter or sour tastes • Decreased salt and sweet taste at 3 days post-BMT • Diminished salt taste at 28 days post-BMT
	Mattson et al. (1992)	10 adult patients during first year post-BMT; 10 other adult patients 2 to 5 years post-BMT	Nonexperimental: descriptive, repeated measures	<ul style="list-style-type: none"> • Changes in bitter, sour, sweet, and salt taste at 3 weeks post-BMT • Changes in salt taste at 3 months post-BMT • No taste changes at 1 year post-BMT • No taste changes at 2 to 5 years post-BMT
Longevity of GI symptoms	Barker et al. (2005)	132 children at 100 days post-BMT	Nonexperimental: retrospective chart review	<ul style="list-style-type: none"> • Mucositis occurred in 90% of patients • Vomiting occurred in 85% of patients • Abdominal pain occurred in 71% of patients
	Iestra, Fibbe, Zwinderman, van Staveren, and Kromhout (2002)	118 adult BMT patients at 50 days and 1 year post-BMT	Nonexperimental: descriptive, repeated measures	<ul style="list-style-type: none"> • Tiredness, anorexia, taste changes, dry mouth, and nausea at 50 days post-BMT • All symptoms persisted but decreased in frequency at 1 year post-BMT • 66% of patients reported eating difficulties at 50 days post-BMT, and 22% of patients reported eating difficulties at 1 year post-BMT
	Lenssen et al. (1990)	127 adults and 65 children at 1 year post-BMT	Nonexperimental: retrospective chart review	<ul style="list-style-type: none"> • 54% of patients with weight gain/weight loss • 23% of patients with oral sensitivity • 18% of patients with xerostomia

NOTE: GI, gastrointestinal; BMT, bone marrow transplant.

reasons for the differences. The persistence of symptoms found at 1 year post-BMT in the study by Lenssen et al. (1990) illustrates the longevity of GI-related symptoms. More research studies need to be conducted to explore symptom duration and the long-term impact of these symptoms.

Eating After Bone Marrow Transplants

There are only 2 articles, including 1 research and 1 review article, which discuss the oral intake in children or adolescents after BMT. Both these articles discussed the time required to resume eating immediately after BMT. Bechard, Guinan, Feldman, Tang, and Duggan (2007) evaluated the mean oral intake among 37 children during the first 4 weeks post-BMT. They found that oral intake significantly declined immediately after the transplant, with a mean oral intake of less than 280 kcal per day for the first 2 weeks post-BMT. The children

required 3 weeks after their BMT before oral intake started to increase, and then, they only consumed 575 kcal per day. Children's oral intake continued to increase at 4 weeks post-BMT, when they were able to consume 725 kcal per day. This oral intake is significantly less than the previously discussed 3000 to 4000 kcal/d required for adolescent BMT patients. Cunningham et al. (1983) reported that children required 36 days after BMT to resume eating 50% of their dietary needs, whereas teenagers required 45 days after BMT to resume eating 50% of their needs. Although this recovery time may be significant, there is no documentation in the article regarding specific research methodology about this finding.

One additional study compared the time to resume adequate oral intake in adult patients who were discharged early to an ambulatory setting ($n = 30$) with that for a group of patients who remained hospitalized ($n = 28$) following their BMT (Stern et al., 2000). Only patients with an oral intake of less than 33% of their

Table 3. Research Studies Related to Complications From Poor Oral Intake

Complication	Author/Year	Sample	Design	Findings
GVHD	Mattsson, Westin, Edlund, and Remberger (2006)	228 adult BMT patients	Nonexperimental: retrospective chart review	<ul style="list-style-type: none"> • No oral intake for 5 to 8 days: 17% incidence of grade III-IV acute GVHD • No oral intake for greater than 9 days: 39% incidence of grade III-IV acute GVHD
Catabolic state	Kyle et al. (2005)	82 adult BMT patients	Nonexperimental: case control	<ul style="list-style-type: none"> • Lower lean tissue and body fat reserves in patients who received steroids when compared with matched healthy volunteers • 38% of patients who received steroids did not gain their pre-BMT lean tissue at 4 to 6 years post-BMT
Length of hospitalization	Papadopoulou, Williams, Darbyshire, and Booth (1998)	39 children during BMT hospitalization	Nonexperimental: descriptive	<ul style="list-style-type: none"> • Malnourished children had an average BMT hospital stay of 34 days • Well-nourished children had an average BMT hospital stay of 27.5 days
Mortality	Deeg, Seidel, Bruemmer, Pepe, and Appelbaum (1995)	1662 adults and 576 children through 150 days post-BMT	Nonexperimental: descriptive	<ul style="list-style-type: none"> • Patients less than 95% of their ideal body weight had a significant increased risk of death during the first 150 days post-BMT • Patients who lost weight during BMT did not have an increased risk of mortality

NOTE: GVHD, graft-versus-host disease; BMT, bone marrow transplant.

estimated needs were enrolled in the study, and the time to resume oral intake was defined as at least 33% of their caloric needs for 3 consecutive days. The ambulatory group required 3 additional days to resume their oral intake as compared with the hospital group. These results may have many confounding factors that were not taken into account, such as the amount of attention and education regarding eating and the type and timing of interventions for symptom relief from the staff in the hospitalized group as compared with the ambulatory group. The factors surrounding these findings should be investigated further to understand the issues more completely, so that effective strategies to improve oral intake can be developed for patients who are hospitalized and discharged.

Complications Related to Poor Oral Intake

Poor nutritional status and poor oral intake has been associated with several morbidity and mortality issues during BMT recovery; however, the majority of this information is obtained from adult literature. Table 3 lists 4 adult and pediatric research studies that have evaluated various complications related to poor oral intake during BMT recovery.

Alterations of fat and carbohydrate metabolism have been noted in underweight or malnourished cancer patients but have been minimally documented in BMT patients. An increase in the rate of lipolysis has been found in cancer patients who are losing weight resulting in seriously high lipid levels in the bloodstream (Rivadeneira, Evoy, Fahey, Lieberman, & Daly, 1998). There is no documentation of lipolysis occurring in BMT patients with weight loss; however, Muscaritoli, Grieco, Capria, Iori, and Fanelli (2002) reported that elevated cholesterol and triglyceride levels commonly occur in BMT patients. This association necessitates investigation. Abnormalities of carbohydrate metabolism, including glucose intolerance and insulin resistance, have been identified in cancer patients with large tumor burdens or metastatic disease (Rivadeneira et al., 1998). Impaired glucose tolerance has also been reported in BMT patients who have received medications such as steroids or cyclosporine or who have experienced a significant infection (Muscaritoli et al., 2002). However, the glucose intolerance issue and related morbidities have not been well researched in BMT patients.

Vitamin and trace element deficiencies have been noted in BMT patients as a result of poor oral intake, malabsorption, medication effects, and increased needs for bone marrow engraftment (Muscaritoli

Table 4. Quality of Life After BMT

Author/Year	Purpose	Measurement Tools	Sample	Findings
Papadopoulou, Lloyd, Williams, Darbyshire, and Booth (1996)	To determine the effects of GI injury and well-being	<ul style="list-style-type: none"> • Diarrhea episodes • Lansky performance scores 	47 children during the first 30 days post-BMT	<ul style="list-style-type: none"> • Children with diarrhea had mean Lansky score of 50 • Children without diarrhea had mean Lansky score of 70
Larson, Viele, Coleman, Dibble, and Cebulski (1993)	To describe symptom experiences from BMT patients and their nurses	<ul style="list-style-type: none"> • Symptom Distress Scale • Profile of mood states 	30 adult BMT patients during the first 30 days post-BMT and 28 nurses caring for those patients	<ul style="list-style-type: none"> • Patient's loss of appetite and inability to eat, even with adequate nutritional support, was very distressing for patients and nurses • Mucositis at 7 days and 14 days post-BMT was very distressing for patients and nurses
Hacker and Ferrans (2003)	To describe QOL immediately after BMT	<ul style="list-style-type: none"> • European Organization for Research and Training Questionnaire • Ferrans and Powers Quality of Life Index • Brief telephone interview at 6 weeks post-BMT 	16 adult BMT patients before BMT, then 2 and 6 weeks post-BMT hospital discharge	<ul style="list-style-type: none"> • Standardized tools: appetite loss, nausea, vomiting, diarrhea, and sleep disturbances significantly affected QOL at 2 weeks posthospital discharge and improved by 6 weeks postdischarge • Telephone interview: 6 patients with fatigue that affected QOL and 1 patient with changes in home routine that affected QOL

NOTE: BMT, bone marrow transplant; QOL, quality of life.

et al., 2002). Deficiencies of vitamin K, vitamin B12, thiamin, magnesium, and zinc are reported to commonly occur in BMT patients, and they require larger than average doses to replace the deficiencies (Papadopoulou, 1998; Sigley, 1998). No studies have documented the duration of vitamin deficiencies or best management for replacement of vitamins.

Quality of Life After Bone Marrow Transplants

GI symptoms along with poor oral intake have been reported in the literature as significantly affecting the quality of life in BMT patients of all ages (Han-Markey, 2000; Keenan, 1989). GI symptoms in general have been reported as uncomfortable and distressing for BMT patients, their families, and their health care providers (Rust et al., 2000). Although these facts have been documented in the literature, there is minimal research to support these statements. Only 3 studies have examined the changes in quality of life related to symptom experiences after BMT; see Table 4. All 3 studies found that GI symptoms were very distressing during the BMT recovery phase. In addition, the brief

telephone survey conducted by Hacker and Ferrans (2003) provided additional symptom experiences beyond the findings from the standardized tools, showing the importance of obtaining subjective information from patients. No study has allowed an opportunity for BMT patients to thoroughly describe their symptom experiences in relation to their quality of life during their BMT recovery.

Nutritional Assessment

There are multiple methods to assess nutrition in individuals, including anthropometric measurements, laboratory markers, and nutritional history. BMT-related literature involves a great deal of controversy surrounding the anthropometrical and laboratory measurement that provides the most accurate nutritional assessment. Surprisingly, only 3 articles mention the need to obtain a nutritional history, despite the importance of this method for gathering information.

Anthropometric measurements, such as height and weight, are quick and easy measurements that are commonly used in clinical practice to evaluate a patient's nutritional well-being. However, weight has

been shown to fluctuate tremendously in BMT patients because of fluid status shifts and electrolyte imbalances and thus may not accurately represent a patient's nutritional status (Keenan, 1989). A study performed by Taskinen and Saarinen (1996) evaluated the weight (obtained by standard scale measurements) and skeletal muscle protein reserve (obtained by ultrasound) in 42 children after BMT. They used analysis of variance to analyze the data. Patients showed weight gain while receiving intravenous nutritional supplementation after BMT, but their muscle protein reserves significantly decreased during this time. The authors felt that the weight gain was a result of fluid accumulation from the nutritional supplementation, whereas the muscle protein reserve represented a more accurate indication of the patient's nutrition because it was not influenced by the administration of fluids. Unfortunately, muscle protein reserve by ultrasound may not be easy to obtain or cost-effective to perform. Midarm circumference and skinfold triceps measurements are 2 anthropometric measurements that are inexpensive and easy to obtain. These tests have been noted to be reliable indicators of muscle and fat (Papadopoulou et al., 1998); however, some authors have reported that these measurements are unreliable because of fluid status changes (Nitenberg & Raynard, 2000; Rivadeneira et al., 1998). It has been reported in the literature that most anthropometric measurements can be useful if the measurements are obtained sequentially and compared over time instead of single measurements compared with age-specific norms (Keenan, 1989; Papadopoulou, 1998).

Laboratory measurements are another customary method to assess the nutritional status in patients. Serum protein markers, such as albumin, prealbumin, and transferrin, are traditionally used to evaluate the nutritional status and responses to nutritional interventions in BMT patients. However, many BMT-related events could affect the accuracy of these tests (Nitenberg & Raynard, 2000). Albumin can be affected by liver or kidney disease, hydration status, or recent blood transfusions whereas transferrin can be affected by anemia or iron overload (Bernstein, Leukhardt-Fairfield, Pleban, & Rudolph, 1989). All these conditions commonly occur after BMT.

In the previously mentioned skeletal protein reserve study by Taskinen and Saarinen (1996), blood samples were drawn from 42 patients before BMT and at 1, 3, 6, and 12 months post-BMT and were analyzed in comparison with skeletal muscle protein reserve

changes. Only serum transferrin levels were found to correlate with muscle protein reserve; albumin levels were not noted to change during the study. However, if as reported, transferrin levels are influenced by anemia or iron overload, then the study's sample may not have been large enough to generalize the findings, because these conditions commonly occur after BMT. Uderzo et al. (1991) measured albumin, prealbumin, and retinol-binding protein levels in 25 pediatric patients who received supplemental nutrition consisting of total parenteral nutrition (TPN) after BMT. Albumin levels did not fluctuate; however, the prealbumin and retinol-binding protein levels showed a statistically significant rise approximately 1 week after starting the supplemental nutrition. Because prealbumin has a half-life of 0.5 days and retinol-binding protein has a half-life of 2 days, these 2 markers have been reported as the most sensitive indicators of recent diet changes and nutritional status (Rivadeneira et al., 1998; Schulte, Reinhardt, Beelen, Mann, & Schaefer, 1998).

A patient's history is one of the most important methods of obtaining data during an assessment; yet only 3 articles mentioned obtaining subjective information as part of the nutritional assessment in BMT or cancer patients. Nutritional assessment as reported in the literature includes the need to assess appetite, 24-hour diet recall, recent diet changes, food preparation methods, use of vitamins and/or supplements, recent weight changes, and GI symptoms (Han-Markey, 2000; Rivadeneira et al., 1998; Sigley, 1998). No research study has evaluated effective means and essential components of obtaining a nutritional history in children or adolescents after BMT.

A qualitative study of 37 healthy women who participated in a food record study reported several factors when discussing errors in their diet record (Vuckovic, Ritenbaugh, Taren, & Tobar, 2000). In focus groups, participants reported changing the type of usual intake to foods that they felt were more socially acceptable and easier to record. The participants also reported inconsistencies in the way they measured their food for recording. Although some of these issues may not be comparable with factors that BMT patients experience, this study does raise concern that diet recall or food records may not be accurate forms of assessment. Research is needed among BMT patients to evaluate if issues are present with diet recalls or food records to ensure that an accurate history is being obtained. The importance of obtaining a nutritional history should not be overlooked in research or in clinical practice.

Symptom Assessment in Adolescents

Larson et al. (1993) reported that the symptom experience of patients undergoing BMT was minimally documented. Fifteen years later there has been little improvement in the documentation of symptom experiences related to BMT. No research study has been performed to subjectively assess the symptom experiences of children or adolescents recovering from BMT; however, there are a few qualitative studies among children and adolescents with cancer that provide significant findings. In a qualitative study of 10 adolescents with cancer, individual interviews were conducted to identify the adolescents' perceptions of their cancer experience (Enskar, Carlsson, Golsater, & Hamrin, 1997). Content analysis was used to identify concepts and categories of perceptions. Physical side effects of the treatment, including nausea, vomiting, changes in smell and taste, anorexia, and fatigue, both acute and chronic, were reported as the worst aspects of the disease. The researchers also found that symptom distress negatively affected the adolescents' development and social life because the symptoms influenced the ability to live their life the way they wanted. In addition, these symptoms were reported as being remembered for a long time after treatment ended.

Symptoms have been defined as subjective expressions that are multifactorial (Larson et al., 1993); yet little information has been provided on these subjective experiences or factors associated with symptoms among adolescent BMT patients. In a qualitative study of 39 children and adolescents with cancer and their parents, symptoms were reported as expected occurrences and were readily accepted as a part of the treatment (Woodgate & Degner, 2003). In interviews with the researchers, the patients and parents reported rarely talking to nurses about mild or moderate symptoms because they felt that the symptoms were a normal consequence of treatment; so they tried to continue on with their daily life. The distress caused from symptoms has not been evaluated in children or adolescents undergoing BMT.

A current method to assess symptoms is to use a standardized measurement tool, such as the Symptom Distress Scale. This form of measurement is quick and easy to use but does not allow the patient to express their experiences in their own words and from their own perspective (Woodgate, Degner, & Yanofsky, 2003). Adolescents have reported disinterest in using scales to measure their symptoms and can become

annoyed with their use because they believe that the scales don't allow for the whole story to be told and don't accurately represent how they really feel (Woodgate et al., 2003). Symptoms can have different meanings to each adolescent, and this individualization is not captured through the use of a standardized measurement tool. Standardized tools are usually designed for adults and do not evaluate aspects that are important in an adolescent's life (Enskar et al., 1997). It is important for adolescents to have an opportunity to discuss what various symptom experiences mean to them because each individual can ascribe different meanings to similar experiences (Ritchie, 2001).

Nutritional Interventions

Nutritional literature associated with BMT contains discussions of various interventions to assist BMT patients; however, much of this documentation deals with interventions occurring during hospitalization without discussion of necessary outpatient follow-up. A great deal of literature surrounds the controversy regarding the use of enteral nutrition (EN) versus TPN, whereas a limited number of other publications provide information about other forms of nutritional support.

The 2 traditional and most common methods to provide nutritional support during BMT hospitalization have been either administration of EN through a nasogastric tube or TPN through a central venous catheter. EN has been shown to be beneficial to patients because it preserves the structure and function of the GI tract and decreases the chance for bacterial dislocation (Andrassy & Chwals, 1998; Rivadeneira et al., 1998). However, EN may not be tolerated because the tube placement and feeds can exacerbate symptoms of nausea, vomiting, and diarrhea that a BMT patient may already be experiencing (Rust et al., 2000). TPN may be better tolerated by BMT patients and can provide more caloric, protein, and vitamin supplementation because the nutrition is received intravenously instead of through an already irritated GI tract (Papadopoulou, 1998). However, TPN has been associated with an increased risk of liver complications and infections and can minimize protein synthesis (Papadopoulou, 1998). Yokoyama et al. (1988) performed a retrospective study among 35 pediatric BMT patients to evaluate BMT complications in relation to their nutritional support. No correlation was observed between an increase in infection rates and the

use of TPN or between bone marrow engraftment time and the use of TPN, although these findings should be generalized cautiously because of the small sample size, with only 5 control patients who did not receive TPN. Only 1 study evaluated the use of TPN versus EN in relation to the BMT patient's well-being. Papadopoulou et al. (1998) evaluated 39 children during BMT hospitalization, who received either TPN or EN, in relation to their well-being as defined by Lansky performance scores. When the nutritional support was completed at BMT hospital discharge, no statistically significant difference was noted in Lansky performance scores between the 2 groups.

Thornley et al. (2004) evaluated the efficacy of ursodeoxycholic acid and vitamin E administration along with TPN in comparison with administration of TPN alone in 37 pediatric BMT patients during their initial BMT hospitalization. Patients who received the ursodeoxycholic acid, vitamin E, and TPN had less mucositis, less hepatic toxicity, and quicker marrow engraftment time when compared with the group that had TPN alone. There were no statistically significant differences between the rate of infection or the occurrence of graft-versus-host disease between the 2 groups. No other studies have been performed to confirm these findings.

Surprisingly, there is minimal literature discussing oral nutritional interventions. BMT patients are often placed on a low microbial diet to minimize potential infections involving their GI tract until bone marrow recovery occurs. This diet requires special preparation to decrease the amount of bacteria, resulting in food with altered tastes and textures that can decrease a patient's willingness to eat (French, Levy-Milne, & Zibrik, 2001). In 1 study, 7 hospitals in the United States and Canada were surveyed for their diet restrictions and infection rates among their pediatric BMT patients (French et al., 2001). The results showed no correlation between infection rates and any of the diet restrictions or food preparation methods. Information regarding the efficacy of the low microbial diet is not conclusive, and more research should be performed so that evidence-based diet restrictions and food preparation can be employed.

Although the use of high calorie energy supplements is commonly encouraged among pediatric BMT patients, there is no literature supporting the use or benefits of this strategy. Poustie, Watling, and Smyth (2003) performed a systematic review to evaluate the efficacy of using high calorie oral supplements in

children with various chronic diseases and found that the effectiveness of oral supplements has only been established in children with cystic fibrosis. Han-Markey (2000) reported that children with oncological issues who were undernourished could benefit from high calorie oral supplementation, but it was reported that the children were often noncompliant in drinking them because of the bad taste; high cost was also a deterrent. No research study has documented this fact. Clearly, more research is needed to evaluate the efficacy and issues involved in the use of oral supplementation.

Patient education is an important part of nursing care; however, no documentation regarding the information needs of nutrition, eating, or eating strategies for BMT patients is available in the literature. Health care providers and patients in outpatient cancer treatment centers across the United States have been surveyed to identify the needs of nutritional information among adult oncology patients (Hartmuller & Desmond, 2004). The nutritional concerns among the nurses, dieticians, and patients contained similar results, with appetite loss being the top concern for education among all 3 groups. The informational needs of the patient also contained similar results among the 3 groups, showing coping with side effects as the primary information need. This study illustrates the importance of nutritional information and education among oncology patients. Further studies need to be performed with BMT patients and specifically adolescent BMT patients to identify their informational needs regarding nutrition, eating, and nutritional interventions. In a qualitative study by Woodgate and Degner (2003), 39 pediatric oncology patients reported in interviews with the researchers that they used self-initiated strategies to relieve their symptoms. Children in this study reported not telling parents or nurses about their strategies because the symptoms were something that they just had to deal with on their own. Research is needed with pediatric and adolescent BMT patients to assess if similar findings are reported.

Summary

Adolescent oncology patients have reported that GI side effects are one of the worst aspects of their disease and treatment (Enskar et al., 1997), but no study has been performed to allow adolescents recovering from BMT to discuss their experiences. There are many factors after BMT that can create significant

GI symptoms that may lead to poor eating and distress in adolescent patients during BMT recovery. Adolescents must be allowed an opportunity to share their experiences so that a more thorough awareness and understanding of the issue can be obtained.

Obtaining information regarding nutrition can be performed in various ways; however, current literature is lacking in a more global assessment analysis. Anthropometric measurements and laboratory markers used for assessment have been well researched, and the issues surrounding their reliability have been scrutinized; yet attention is significantly lacking on the important assessment tool of nutritional history. Although some studies have listed patient history as an important part of an assessment, the specific components of a history have not been identified. Furthermore, researchers have commonly used standardized tools to measure subjective experiences; however, adolescents have shown that the use of standardized tools is not an effective way to measure their symptom experience. No qualitative study has been performed to allow adolescents to subjectively share their experiences during BMT recovery. When specifically questioned, children with oncological problems report not sharing their symptom experiences or self-initiated strategies because they felt that they just had to deal with it. No child or adolescent should have to manage a multitude of intense symptoms or develop strategies alone during the lengthy BMT recovery.

Current BMT nutritional research is strongly influenced by a medical philosophy with evaluation of nutritional assessment measurements and nutritional interventions centering on medical management. Although these are important aspects to assess, a broader analysis of the nutritional issues needs to be performed. To provide effective and thorough care to BMT patients during their recovery, the knowledge base of nutritional and eating issues after BMT needs to become more comprehensive. The nursing profession is lacking involvement in performing research to evaluate eating and nutritional issues among adolescents recovering from BMT. Nurses have excellent interview and listening skills, which makes them ideal candidates to perform research that allows the children and adolescents to express their eating issues in their own terms and share personal strategies that assist them to overcome their issues. Only after these issues have been identified can the health care staff develop more effective strategies to aid patients throughout their BMT recovery.

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