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ORIGINAL ARTICLE

Changes in nutritional status, body composition, quality of life, and physical activity levels of cancer patients undergoing autologous peripheral blood stem cell transplantation

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Abstract
Purpose This pilot exploratory study aimed to describe the changes in nutritional status, body composition, quality of life (QoL), and physical activity levels (PAL) of cancer patients undergoing high-dose conditioning and autologous peripheral blood stem cell transplantation (PBSCT) at pre-admission, hospital discharge, and at 100 days post-transplantation, and to examine if changes in these parameters are interrelated.
Methods Twenty-four patients (56.2±12.9 years; 7 females, 17 males) were recruited from an Australian transplant center. Assessment was prospectively conducted at pre-admission, hospital discharge, and 100 days post-transplantation using the scored patient-generated subjective global assessment, air displacement plethysmography, EORTC QLQ-C30 (version 3), and the international physical activity questionnaire.
Results At discharge, nutritional status deteriorated (patient-generated subjective global assessment (PG-SGA) median, +8.0; interquartile range, 6.0–13.0; $p<0.001$) and the number of malnourished patients increased ($n=8/23$; $p=0.023$). Patients experienced significant loss of lean body mass (LBM; −2.2 kg, CI 95 % −3.0, −1.4; $p<0.001$), and decrease in QoL (−10.6, CI 95 % −24.1, 2.9; $p=0.117$); the proportion of patients with high PAL decreased ($p=0.012$). By 100 days post-transplantation, all patients were well-nourished; however, LBM remained lower −1.0 kg (CI 95 % −1.9, −0.1; $p=0.028$). Change in nutritional status (PG-SGA score) was associated with weight ($r=-0.46$; $p=0.039$) and fat mass ($r=-0.57$; $p=0.013$). Change in QoL was associated with nutritional reservoir (i.e., fat; $r=0.54$; $p=0.024$); QoL was consistently higher for patients with high PAL.
Conclusions High-dose conditioning and autologous PBSCT is associated with deterioration in nutritional status, QoL and PAL, with LBM remaining below baseline levels at 100 days post-transplantation. A nutrition and exercise intervention program post-hospital discharge may be beneficial for these patients.

Keywords Nutrition assessment · Patient-generated subjective global assessment · Body composition · Quality of life · Peripheral blood stem cell transplantation

Abbreviations

APD	accredited practicing dietitian
BEAM	BCNU etoposide aracytine, melphalan

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BMI	body mass index
FM	fat mass
HDC	high-dose conditioning
HGS	hand grip strength
IPAQ	International Physical Activity Questionnaire
LBM	lean body mass
PAL	physical activity levels
PBSCT	peripheral blood stem cell transplantation
PG-SGA	patient-generated subjective global assessment
QoL	quality of life
SGA	subjective global assessment

Introduction

High-dose conditioning (HDC) and adjunct peripheral blood stem cell transplantation (PBSCT) is a globally accepted method for treatment of hematological malignancy (i.e., leukemia, lymphoma, and myeloma) [1]. Despite the advantage of increased dose–response effect, the treatment is accompanied by severe gastrotoxicity and nutrition impact symptoms which may compromise food intake [2]. Weight loss is commonly reported post-transplantation but the evaluation of nutritional status using validated assessment methods is poorly documented except in one study [3, 4].

There is a shortage of research investigating ongoing supportive care for PBSCT survivors despite reports of persisting side-effects associated with the treatment. Issues experienced by long-term transplant survivors included: unresolved nutrition impact symptoms [5]; incomplete recovery of muscle mass [6]; and reduced functional capacity (i.e., reduced physical activity levels (PAL)) [7]. These issues may potentially affect patients' long-term quality of life (QoL). No studies have investigated these outcomes among PBSCT patients concurrently. This pilot exploratory study aimed to describe the changes in nutritional status, body composition, QoL, and PAL of cancer patients undergoing HDC and autologous PBSCT at pre-admission, discharge, and at 100 days post-transplantation and to examine if changes in these parameters are interrelated.

Patients and methods

Ethics approval was granted by the multidisciplinary ethics committee of the hospital (ref: 1017) and The University of Queensland (ref: HMS10/0306.r1). All patients provided written informed consent. Eligible candidates were cancer patients (aged ≥18 years) scheduled for autologous PBSCT from a single transplant center, the Haematology and Oncology Clinics of Australia, The Wesley Hospital, Brisbane, Australia. Age, gender, diagnosis, and treatment, were obtained from the medical chart. Variables of interest were assessed at pre-admission, discharge, and at 100 days post-transplantation (day+100).

Nutritional status was assessed by the valid and reliable scored patient-generated subjective global assessment (PG-SGA) [8, 9]. Patients are categorized as well-nourished (SGA A), moderately or suspected of being malnourished (SGA B), or severely malnourished (SGA C). The PG-SGA has a scoring system which includes: a patient-completed medical component (weight loss, nutrition impact symptoms, dietary intake, and functioning), and a clinician-completed component (diagnosis, age, metabolic stress, and physical examination). This system enables clinicians to rank the nutrition risk of individuals within the same SGA category; an increase in PG-SGA score reflects greater risk for malnutrition. Nutrition education is recommended for a total PG-SGA score of 2–3, while nutrition intervention is recommended for scores ≥4–8; a score of ≥9 indicates a critical need for nutrition intervention. A change in score ≥5 is clinically significant (based on professional opinion).

Dietary intake was assessed with the 24-h recall method [10] by a hospital dietitian (accredited practicing dietitian (APD)) or the principal investigator (also an APD); this was the standard practice of the hospital for acutely ill patients. Inter-rater variability for dietary assessment was minimized using a standard assessment form which guided the interview through the main meals, and in-between meal snacks; a checklist of common food items was included. Energy and protein intake were analyzed by the software FoodWorks version 5 for windows (Xyris software Pty Ltd 2009, Brisbane, Australia). A difference in protein intake of 10 g/day is clinically significant [11].

Body composition assessments were completed by the principal investigator. Participants were assessed in a tight-fitting, one-piece Lycra suit provided by the laboratory. All jewelry was removed. Height was measured to the nearest 0.1 cm using a wall-mounted stadiometer. Weight, fat mass (FM), and lean body mass (LBM) were assessed by air displacement plethysmography (Bod Pod, COSMED, Concord, CA, USA) which is equivalent to underwater weighing [12]. A change in LBM of ≥1 kg is considered clinically significant [13].

The EORTC QLQ-C30 (version 3), a validated self-administered questionnaire, was used to assess QoL [14]. The instrument contains 30 items that assess global QoL and five functional scales (physical, role, cognitive, emotional, and social). Results were converted to a score out of 100, with a higher score reflecting better QoL and functioning. Clinical significance for global QoL was determined by mean differences according to the recently published evidence-based guideline: trivial (0–4), small (5–10), medium (11–15), and large (>15) [15]. Clinical significance recommendations on the functional scales are detailed in the guideline except for emotional functioning which could not be determined.

The short-form International Physical Activity Questionnaire (IPAQ) was used to assess PAL [16]. The

tool contains seven items which assess PAL over the last 7 days. Responses were given by frequency (days per week) and time (hours and minutes) spent on three types of activities including: walking, moderate intensity and vigorous intensity activities. PAL was coded as a categorical variable (low, moderate, and high PAL) based on the IPAQ scoring protocol (revised 2005; www.ipaq.ki.se).

Hand grip strength (HGS) was included as an objective measure for functioning [17]; assessment was completed in the standing position with a hand spring dynamometer (TTM Muscular Meter, Tokyo, Japan) three times on the dominant hand; the highest score was documented [18].

Statistical analysis was performed with R for windows (version 1.13.1, ©2011 The R Foundation for Statistical Computing). Baseline characteristics were compared between genders using the *t* test or Wilcoxon's rank sum test in the case of continuous variables and Fisher's exact test for categorical variables. The mean or median change in a continuous variable between two time points was assessed using paired *t* test or Wilcoxon's rank sum test. Changes in categorical variables were assessed with McNemar's test. Associations between percentage changes of continuous variables were tested with Pearson correlation or Spearman correlation; associations between categorical and continuous variables were tested with the Kruskal–Wallis test. Statistical significance was set at $p<0.05$ however clinical significance of the results was also considered.

Results

Twenty-four consecutive patients undergoing autologous PBSCT (70.8 % male; mean age, 56.2±12.9 years) were recruited over a period of 11 months (30 June 2010 to 31 May 2011); 11 eligible candidates declined participation. Reason for nonconsent was due to perceived burden of the study (i.e., inconvenience due to time or travel distance). Four participants were recruited but excluded from analysis because they underwent allogeneic PBSCT.

Baseline characteristics are shown in Table 1. HGS, LBM, and protein intake were significantly higher among males. Baseline measurements were obtained on an average of 5±4 days before admission excluding the dates of two outliers (23 and 33 days) who could not attend the hospital within the preferred period of assessment due to geographical location; overall, median transplantation day was 2.5 days (range, 2–9 days) after admission, and mean length of hospital stay was 23±7 days.

Nutritional status and body composition

Changes in nutritional status, body composition, dietary intake, and hand grip strength over time are shown in Table 2. The majority of participants were well-nourished ($n=23/24$) at pre-admission; no patient was underweight (body mass index, <18.5 kg/m^2) [19]. At discharge, there was an increase in the proportion of malnourished (SGA B and C; $n=1/24$ at pre-admission versus $n=8/23$ at discharge, $p=0.023$); all nutritional parameters decreased significantly and median PG-SGA score reached 10.0 (interquartile range, 9.0–14.0). Between discharge and day+100 nutritional parameters improved but weight, FM, and LBM remained significantly lower than pre-admission with a mean change (95 % CI) in LBM of −1.0 kg (−1.9 and −0.1) which was statistically and clinically significant; percentage difference of body composition compared to pre-admission are shown in Fig. 1. By day+100, all patients were classified as well-nourished ($n=20/20$); however, median PG-SGA score was 3.5 (interquartile range, 2.0–7.0), which was higher than baseline ($p=0.014$). The distribution of PG-SGA scores suggested all patients at discharge ($n=23/23$); and up to 50 % ($n=10/20$) of the patients at day+100 still required nutrition intervention (scores ≥4) [9].

Global QoL

Changes in global QoL and functional scales are presented in Table 3. At discharge, mean decreases in global QoL were clinically significant; while mean decreases in all functioning scales were statistically and clinically significant (clinical significance of emotional functioning is unknown). Scores improved between discharge to day+100. By day+100, global QoL returned to pre-admission levels or above; increase was of small clinical significance.

Physical activity levels

Distribution of PAL at each time point is shown in Table 2. At discharge, more patients reported low PAL compared to pre-admission ($p=0.01$); by day+100, more patients reported high PAL compared to discharge ($p=0.01$); and by day+100, the distribution of PAL was similar to pre-admission.

Association between outcomes

Results suggested changes (in percentage) in nutritional status, body composition, and QoL between pre-admission and day+100 are interrelated. Change (in percentage) in global QoL was associated with change (in percentage) in FM ($r=0.54$, $p=0.024$); change (in percentage) in weight was associated with change (in percentage) in FM ($r=0.89$, $p<0.001$), LBM (in percentage; $r=0.61$, $p=0.007$), and PG-SGA score (in percentage) ($r=-0.46$, $p=0.039$); change (in percentage) in PG-SGA score was associated with change (in percentage) in FM ($r=-0.57$, $p=0.013$); change (in percentage) in HGS was associated with change (in percentage)

Table 1 Baseline characteristics of 24 patients undergoing autologous peripheral blood stem cell transplantation

Variable	Female $N=7$	Male $N=17$	Overall $N=24$	p value[a]
Age (years)	55.1±13.6	56.6±12.9	56.2±12.9	0.801
Weight (kg)	72.7±22.7	89.0±12.3	84.3±17.2	0.113
BMI (kg/m^2)	23.6 (21.6–29.1)	28.5 (25.4–32.3)	27.9 (23.7–31. 9)	0.147[b]
BMI category, *n* (%)				0.143[c]
Normal (18.5–24.9 kg/m^2)	5 (71.4)	4 (23.5)	9 (37.5)	
Overweight (25.0–29.9 kg/m^2)	1 (14.3)	7 (41.2)	8 (33.3)	
Obese (≥30 kg/m^2)	1 (14.3)	6 (35.3)	7 (29.2)	
SGA category, *n* (%)				1.000[c]
Well nourished (SGA A)	7 (100)	16 (94.1)	23 (95.8)	
Malnourished (SGA B/C)	0 (0)	1 (5.9)	1 (4.2)	
PG-SGA score	2.0 (1.0–4.0)	2.0 (1.0–4.5)	2.0 (1.0–4.0)	0.896[b]
Energy intake (kJ)	6,407±1,630	8,274±2,049	7,729±2,089	0.044
Protein intake (g)	74.2±28.9	105.3±27.0	96.2±30.5	0.020
Lean body mass (kg)	40.5±7.1	56.3±6.7	51.7±9.9	<0.0001
Hand grip strength (kg)	25.8±5.1	41.1±9.4	36.7±10.9	0.001
Physical activity levels, n (%)[d]				0.530[c]
High	3 (42.9)	5 (31.3)	8 (34.8)	
Moderate	3 (42.9)	4 (25.0)	7 (30.4)	
Low	1 (14.3)	7 (43.8)	8 (34.8)	
Diagnosis, *n* (%)				1.000[c]
Multiple myeloma	4 (57.1)	9 (52.9)	13 (54.2)	
Lymphoma	2 (28.6)	5 (29.4)	7 (29.2)	
Hodgkin's lymphoma	0 (0.0)	2 (11.8)	2 (8.3)	
CLL/SLL	1 (14.3)	1 (5.9)	2 (8.3)	
Treatment, *n* (%)				1.000[c]
BEAM	3 (42.9)	8 (47.1)	11 (45.8)	
Melphalan	4 (57.1)	9 (52.9)	13 (54.2)	

Values are presented as mean± standard deviation, median (25th–75th percentiles) or *n* (in percentage)

BEAM BCNU etoposide, aracytine, melphalan, *BMI* Body mass index categories [19], *CLL/SLL* chronic lymphocytic leukemia/small lymphocytic lymphoma, *SD* Standard deviation, *SGA* Subjective global assessment, *PG-SGA* Patient-generated subjective global assessment [9]

[a] p values are for comparisons between genders using independent t test

[b] p values are for comparisons between genders using Wilcoxon rank sum test

[c] p values are for comparisons between genders using Fisher's exact test

[d] $N=23$

in LBM ($r=0.46$, $p=0.056$), but not PAL and physical functioning. The distribution of QoL was not the same for all levels of PAL (pre-admission, $p=0.048$; discharge, $p=0.019$; day+100, $p=0.080$). Indeed, mean global QoL was consistently higher for those patients with high PAL when compared to those with low PAL. For nutritional status, there were insufficient numbers distributed between SGA A and SGA B/C at pre-admission and day+100 for subgroup analysis; at discharge, no significant difference between the SGA groups was observed.

Discussion

All measured outcomes were adversely affected after PBSCT, and not all changes were completely reversed by 100-days post-transplantation. The majority of transplant candidates were well nourished before treatment which concurs with the findings of two previous studies examining PBSCT patients [3, 4]. After transplantation, nutritional assessment revealed survivors were at risk of poor nutritional status. At discharge, the number of well-nourished patients decreased which translated to one in two becoming malnourished and all patients were indicated for nutrition intervention (PG-SGA scores ≥4) [9]; mean increase in PG-SGA score of 9 (pre-admission to discharge) was clinically significant. Even though the majority of patients were categorized as well-nourished (SGA A), by day+100 the distribution of the PG-SGA score indicated one in two survivors met the recommendation for nutritional intervention (scores ≥4). Elevated PG-SGA score at day+100 was primarily due to a combination of overall weight loss, food intake at a level perceived as less than usual, incomplete recovery of functioning, or presence of nutrition impact symptoms; up to one in three patients ($n=7/20$) reported ≥1 nutrition impact symptom.

Due to limited prospective studies assessing dietary intake after PBSCT, the duration until intake returns to normal is unclear. Dietary energy intake can fall to a nadir of 3 to ≤56 % of the daily requirement after the onset of gastrotoxicity

Table 2 Change in nutritional status, body composition, dietary intake, hand grip strength, and physical activity level, between pre-admission T0, hospital discharge T1, and 100 days post-transplantation T2

Variable	T0 to T1 *N*=22	T1 to T2 *N*=20	T0 to T2 *N*=20
Weight (kg)	−5.7 (−7.1 to −4.2)*	1.4 (−1.2 to 3.9)	−4.6 (−7.1 to −2.1)*
Fat mass (kg)	−3.5 (−4.6 to −2.4)*	−0.4 (−2.3 to 1.5)[a]	−3.8 (−5.7 to −1.9)[a]*
Lean body mass (kg)	−2.2 (−3.0 to −1.4)*	1.3 (0.1 to 2.5)[a]**	−1.0 (−1.9 to −0.1)[a]**
PG-SGA score	8.0 (6.0 – 13.0)[b]***	−7.5 (−9.0 – −3.5)***	1.0 (0.0 – 4.0)****
Energy (kJ)	−2,535 (−3,803 to −1267)*	1,928 (1,071 to 2,785)[c]*	−92 (−1,069 to 885)
Protein (g)	−36.1 (−50.0 to −22.2)*	24.6 (8.4 to 40.7)[c]**	−5.4 (−19.1 to 8.3)
Hand grip strength (kg)	−2.0 (−3.6 to −0.5)**	2.0 (−0.1 to 4.1)[c]	0.0 (−1.8 to 1.8)[c]
Physical activity level, *n* (%)	T0[b]	T1[d]*****	T2******
High	8 (34.8)	3 (13.6)	12 (60)
Moderate	7 (30.4)	2 (9.1)	2 (10)
Low	8 (34.8)	17 (77.3)	6 (30)

Values are presented as mean change (95 % CI), or median change (25th–75th percentiles) or *n* (in percentage)

[a] *N*=18

[b] *N*=23

[c] *N*=19

[d] *N*=22

*$p<0.001$, significant change over time, paired *t* test; **$p<0.05$, significant change over time, paired *t* test; ***$p<0.001$, significant change over time, Wilcoxon rank sum test; ****$p<0.05$, significant change over time, Wilcoxon rank sum test; *****$p<0.05$, significant change compared to T0, McNemar's test; ******$p<0.05$, significant change compared to T1, McNemar's test

(typically, days −1 to +14) [20, 21]. By discharge, our results showed energy and protein intake recovered to 63 and 60 % of the baseline level respectively, which suggests PBSCT recipients can experience inadequate dietary intake for at least 2–3 weeks. By day+100, energy and protein intake were comparable to pre-admission (102±26 and 99±37 %, respectively); however, the plateau of weight and FM since discharge suggests a higher intake may be needed to replenish the loss of nutrition reservoir (i.e., weight and FM) or muscle loss (i.e., LBM). Further, dietary intake appears optimistic at the group level; a small proportion (*n*=4/20) of patients in this study continued to consume less than 80 % of their baseline intake at day+100. One prospective study suggested up to 30 % of the PBSCT survivors still experience eating difficulties at day+125 and up to 22 % at 1 year post-PBSCT [22].

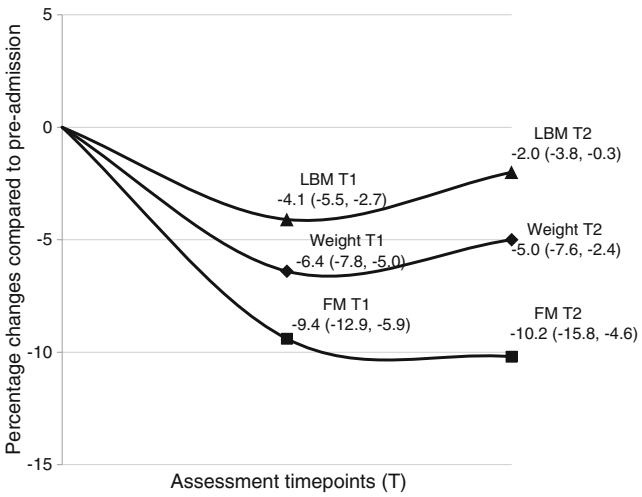

Fig. 1 Mean changes (95 % confidence interval) in body composition at pre-admission, discharge, and 100 days post-transplantation presented as percentage difference to pre-admission level

Weight loss after PBSCT was predominantly from fat in this patient group; however, the overall loss of LBM was significant. At discharge, three in four patients (*n*=16/22) lost ≥1–2 kg of LBM; this deficit remained among one in two (*n*=9/18) patients at day+100. Restoration of LBM may be delayed when patients continue to experience poor dietary intake and low PAL. Although the association between LBM and other variables was not significant in this study it has been well-established that stress conditions (i.e., inflammation, surgery, and cancer) [23], negative energy and nitrogen balance [24], and prolonged bed rest [25] are detrimental to the maintenance of muscle, all of which, were experienced by these patients. Over a period of 4–6 years post-transplantation, Kyle el al. [6] found LBM did not recover to pre-admission level, further, weight gain in the form of FM was more rapid than LBM. This is concerning as fat gain masks muscle deficit, while reduced LBM is associated with poor survival among cancer patients [23]. It may be worthwhile to consider the provision of ongoing support

Table 3 Change in global quality of life and functioning scales (EORTC QLQ-C30) between pre-admission T0, hospital discharge T1, and 100 days post-transplantation T2

Variable	T0 to T1 *N*=21	T1 to T2 *N*=20	T0 to T2 *N*=20
Global quality of life	−10.6 (−24.1 to 2.9)	14.5 (0.4 to 28.6)*	4.6 (−2.4 to 11.6)
Physical functioning	−24.1 (−32.6 to −15.6)**	24.1 (16.7 to 31.5)**	1.1 (−5.3 to 7.6)
Role functioning	−48.4 (−63.9 to −32.9)**	50.0 (35.3 to 64.8)**	4.2 (−5.8 to 14.3)
Emotional functioning	−8.0 (−16.5 – 0.0) ***	12.0 (5.0 – 31.0)****	8.0 (0.0 – 13.0)***
Cognitive functioning	−17.0 (−33.5 – −8.0) ***	17.0 (4.0 – 45.8)****	0.0 (0.0 – 16.8)
Social functioning	−33.0 (−34.9 – −16.5)****	33.5 (16.0 – 62.8)****	0.0 (0 – 17.0)

Values are presented as mean change (95 % CI), or median change (25th–75th percentiles)

* $p<0.05$, significant change over time, paired *t* test; ** $p<0.001$, significant change over time, paired *t* test; *** $p<0.05$, significant change over time, Wilcoxon's rank sum test; **** $p<0.001$, significant change over time, Wilcoxon's rank sum test

programs involving a combination of nutrition and exercise for transplant patients for the preservation of LBM.

HDC and PBSCT had an adverse impact on global QoL and all functioning scores but the effect was temporary. At hospital discharge, decrease in global QoL was rated medium in terms of clinical significance while significance in the decreases of all functioning scores were rated large based on the Cocks et al. criteria [15]. By day+100, global QoL and all functioning scores were similar to baseline; the increase in global QoL was of small clinical significance. Consistent with the finding of literature, recovery in global QoL and functioning scores at day+100 was observed in a study on autologous recipients [26]. It is possible that self-perceived QoL and functioning scores were perceived as good shortly after transplantation because impairments to daily functioning is not apparent until patients resume usual activities (i.e., work). This is suspected because studies on long-term transplant survivors (i.e., ≥1 year) have observed a deficit in functioning scores [27, 28] or scores were good but were lower than the general population [29, 30].

Significant decrease in PAL was observed during the active treatment period (i.e., between pre-admission and discharge); similar results were observed in two prospective studies [7, 31]. In contrast, however, our results showed patients were able to resume PAL by 100 days post-transplantation; this may be because our sample was slightly younger. In both prospective studies, reduction in PAL was due to the decrease in moderate and strenuous intensity exercises compared to pre-transplant.

Global QoL assessed by the EORTC QLQ-C30 was correlated with change in nutrition reservoirs (i.e., fat) [32] and PAL [33]. Mean global QoL was consistently higher among the high-PAL group, followed by moderate- and low-PAL group. Exercise interventions have demonstrated benefits across a number of physiological and psychological outcomes among general cancer patients including those treated with PBSCT [34], but further research is needed to confirm whether better QoL was related to higher PAL or patients reporting high PAL had different characteristics compared to those reporting low PAL such as fewer complications during PBSCT. Although not significant, there was an inverse association between nutritional status and global QoL [35, 36]. The magnitude of change in global QoL related to PG-SGA score was less than reported among a group of head and neck cancer patients, where a change in PG-SGA score by 9 led to a change in global QoL score by 17 [35]. This discrepancy may be due to the difference in treatment and cancer diagnosis.

Change in HGS did not correlate with global QoL and physical functioning (i.e., PAL and mobility) which was inconsistent with the literature [17]. The lack of correlation may be due to confounding factors. For one, patients are advised to avoid crowded environments and certain activities (i.e., gardening) which may expose them to the risk of infection; these recommendations apply up to 100 days post-transplantation regardless of patients' functioning capacity. Restriction to daily activities and social interactions may adversely affect self-perceived QoL and PAL, independent to the recovery of the body (i.e., strength). Further research is needed to determine if HGS can be included as an objective measure of QoL and PAL among patients treated with PBSCT.

A limitation shared among studies involving PBSCT patients is the heterogeneity of sample characteristics (i.e., regimen, diagnosis, and age) and the difficulty to conduct subgroup analysis due to small sample size (i.e., <100). The use of 24-h recall estimated current dietary intake and may not reflect day-to-day variance but it provided the least patient burden compared to food diaries which may be inappropriate for acutely ill patients. The presence of excess fluid and foreign objects (i.e., Hickman's line) at the time of body composition assessments may have affected the results.

In conclusion, our study found: the adverse effects of HDC and autologous PBSCT on body composition were not completely reversed by 100 days post-transplantation; patients are not malnourished by 100 days post-transplantation but may require nutritional support from dieticians to address persisting nutrition impact symptoms; lastly, patients perceived QoL returned or improved compared to pre-admission. Cancer survivors treated by autologous PBSCT are in need of ongoing supportive care to address persisting altered body composition in particular LBM. Clinical trials are needed to investigate whether nutrition and PAL have a positive impact on the maintenance of LBM and QoL among patients undergoing autologous PBSCT.

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