Effect of Exercise Intervention on White Blood Cell Count and Duration of Hospital Stay among Patients Undergoing Allogenic Bone Marrow Transplantation

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Abstract: Bone marrow transplantation (BMT) is a therapeutic procedure aimed at curing various forms of malignant hematological diseases. Preliminary evidence indicates that physical exercise may be an effective strategy for patients undergoing (BMT). Nursing research in the area of physical exercise concerning patients undergoing (BMT) has been nearly scares despite its importance to patients' physical and psychosocial outcomes. Some studies demonstrated that exercise has a positive impact on immune system function, white blood cells and duration of hospital stay. The objectives of this study were to examine the effect of exercise intervention on white blood cell count and duration of hospital stay among patients undergoing allogenic bone marrow transplantation. It was hypothesized that the patients undergoing BMT who will be exposed to exercise intervention (study group) will have improved white blood cell count and reduced hospital stay, compared to the patients in the control group who will not be exposed to exercise intervention. A quasi-experimental research design has been utilized.The study was conducted at the Bone Marrow Transplant Unit in Naser Teaching Institute in Cairo-Egypt. A purposive sample of patients was included in the study. Inclusion criteria include the following: Adult patients, admitted to BMT unit for the procedure of BMT, all had a diagnosis of leukemia, severe a plastic anemia, patients should be able to communicate with the researchers and understand the goals and procedure of the study, physically able to perform exercise sessions as approved by physician. The tools were used to collect data related to this study were; patient's assessment and clinical data sheet, patient's exercise observation sheet, and patient's complications monitoring sheet. The findings of this study showed improving of white blood cells count in patients undergoing BMT in the study group after implementation of exercise intervention. The present study findings reported increase in white blood cell differential count including neutrophils, lymphocytes, monocytes, basophilic and easinophilic count for BMT patients. The present study results showed a highly significant $p<0.01$ decrease in hospitalization days for patients in the study group received exercise intervention compared to patients in the control group. It is concluded that the effect of exercise intervention starts to show significant difference $p<0.05$ at 14 days of exercise implementation which means that the effect of exercise improves the total and differential white blood cell count and reduced hospital stay. (1) **What is already known about the topic?** Exercise intervention has been associated with benefits for patients during and following BMT, including improvements in physical and psychosocial outcomes. (2) **What this paper adds?** This study demonstrates that physical exercise intervention could improve white blood cell count and reduce hospital stay for patients undergoing BMT.
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1. Introduction:

Bone marrow transplantation is a therapeutic procedure aimed at curing various forms of malignant hematological diseases. It has been progressively applied to other forms of oncological pathologies as well (Menoni and Ridolfi, 2008). BMT may have some irreversible consequences on various levels, biological, psychological and social levels. It may involve, for example loss of fertility, capacity of work (Lee *et al*., 2005, Schulz-Kindermann *et al*., 2002). Muscle weakness (Mello *et al*., 2003) pain, fatigue and other treatment related symptoms (Stevenson and Fox, 2005).

Hematological malignances are the types of cancer that affect blood, bone marrow, and lymph nodes. As the three are intimately connected through the immune system, a disease affecting one of the three will often affect the others as well. Hematological malignances are neoplasms, may drive from either of the two major blood cell lineages: myeloid and lymphoid cell lines. The myeloid cell line normally produces granulocytes, erythrocytes, thrombocytes, macrophages and mast cells; the lymphoid cell line produces B, T, NK and plasma cells. Lymphomas, lymphocytic leukemia and myelomes are from the lymphoid line (Goldsby *et al*., 2003; Parham, 2005).

A plastic anemia is a condition where bone marrow does not produce sufficient new cells to replenish blood cells. A plastic anemia patient has lower counts of all three blood cell types: red blood cells, white blood cells and platelets (Locascilli, 2007).

In the last 10-15 years, epidemiological research has demonstrated the important protective and preventive role of physical exercises in terms of developing cancer (Wiskemann and Huber, 2008).

Young-McCaughan (2006) stated that there is evidence in a growing body of research concerning exercise in patients with cancer; over 150 studies have been published showing the nearly universal benefits of exercise in this patient population. Exercise prevents decline and or improves cardio-respiratory function, improves body composition, body image, improves immune function, reduces the number and severity of side effects, reduces hospital stay, allows for better adjustment to illness and reduces stress, all of which contribute to improvements in quality of life (Hayes and Newman, 2006, Courney and Friednreich, 2007).

Mechanisms by which exercise increases cancer patient's survival are numerous and varied ranging from improved immune function to reduced impact of other chronic diseases. The enhanced physical and psychological health conferred by exercise to reduced morbidity and mortality (Newton and Galvao, 2008).

Physical exercise in patients undergoing BMT has been shown to have beneficial effects on functional capacities and fatigue (Wiskemann and Huber, 2008), immunity (Coleman *et al*., 2003), physical and emotional well being (Defor *et al*., 2007), quality of life (Hayes *et al.*, 2004), duration of neutropenia, thrombocytopenia and hemoglobin concentration (Dimeo *et al*., 1997) and lymphocyte count (Kim and Kim, 2006).

Some studies have indicated that physical activity has positive impact on the human immune system and its functioning (Mackinnon, 1992, Hilton, 1996, Galvao *et al*., 2008). Functions of the immune system include those of the B-lymphocytes and T-lymphocytes as well as those of the phagocytes and complement system. B cells and T cells carry out specific immune responses. Neutrophils are one of the types of WBCs and thus reflect the status of the immune system. B cells, a type of white blood cells, can recognize foreign proteins (antigens) and make specific proteins (antibodies) to destroy antigens (humeral immunity). T cells, other types of white blood cells perform a number of functions (cell-mediated immunity). The phagocyte and complement systems bring about a non-specific immunity responses.

The control working theory in the field of exercise immunology is the "inverted J hypothesis". This hypothesis predicts that exhaustive physical exercise leads to an elevated risk of infectious disease (reduced immuno-surveillance), whereas as a moderate exercise workload reduces infection risk (increased immuno-surveillance) (Nieman, 2000).

Exercises have the capacity to protect and even enhance the immune response. Experimental studies have shown that a regular exercise program can bolster many defenses of the immune system, including the antibody response and the natural killer (T cells) response. A relatively low level of aerobic exercise can protect the immune system and maintain a healthy immune response (Wyle, 1997, Gladson, 2006).

Physical exercise constitutes a potentially promising intervention to reduce physical and psychological stress and increase immunity with the framework of bone marrow transplantation, because of its multi-dimensional effectiveness. Over the last few years, however, increasing efforts have been made to utilize exercise-based interventions for patients undergoing bone marrow transplantation (Wiskemann and Huber, 2008).

Significance of the study:

Nursing has a strong tradition of focusing on various ways of knowing to provide excellent care. Evidence based practice is a way to frame and address questions about how to provide the best patient care. Within the nursing profession, it is expected that new information in the form of research findings will be incorporated constantly and knowledgeably into the nursing practice to provide the best patient care. Nursing research in the area of physical exercises concerning patients undergoing BMT has been nearly scares despite its importance to patient's condition. Preliminary data from Dimeo et al (1997); Hayes *et al* (2003) and Kim and Kim (2006) have suggested that exercise intervention for patients undergoing BMT allows improve in white blood cell count and shorten hospital stay. Exercise intervention for BMT patients should be seen as vital adjuvant therapy aimed at maintaining or improving structure and function, alleviating symptoms and assisting recovery of patients (Hayes *et al.*, 2009). It is a simple procedure, easily carried out by nurses and could establish good rapport between the patient and the nurse. Also, it is important for enhancing the role of nurses.

Aim the study:

The aim of this study was to examine the effect of exercise intervention on white blood cell count and duration of hospital stay among patients undergoing allogenic bone marrow transplantation.

Research hypothesis:

It was hypothesized that the patients undergoing BMT who will be exposed to exercise intervention (study group) will have improved white blood cell count and reduced duration of hospital stay, compared to the patients in the control group who will not be exposed to exercise intervention.

2. Subjects and Methods:

Research Design:

A quasi-experimental research design has been utilized in this study.

Research setting:

The study was conducted at the Bone Marrow Transplant Unit in Naser Teaching Institute in Cairo - Egypt.

Subjects:

Purposive sample of patients were included in the study. Patients for this study had a diagnosis of leukemia or severe a plastic anemia and all had received allogenic bone marrow transplantation in BMT unit. Patients divided randomly into two equal groups (20 patients each) to constitute the study and control groups. Those who admitted first carried odd numbers constituted the study group patients and even numbers assigned to control group. Inclusion criteria include the following: Adult patients admitted to BMT unit for the procedure of BMT, all had a diagnosis of leukemia, severe a plastic anemia. Patients should be able to communicate with the researchers and understand the goals and procedure of the study, physically able to perform exercise sessions as approved by physician.

The sample size was estimated with STATA 10 program. The estimated required sample size was 20 patients in each group, to achieve power of study 80%, power = 0-8000 and alpha=0.0500.

Study tools:

The following tools were used to collect data related to this study:

- Patient's assessment and clinical data sheet: The sheet was designed by the researchers to gather information related to age, sex, education of patients and, also covered data related to medical diagnosis, diagnostic procedures, lab investigation, homodynamic parameters, duration of illness, medication taken and date of hospital admission, transplantation and discharge.
- Patient's exercise observation sheet: Adopted from Dimeo *et al* (1996), Mello *et al* (2003), Kim and Kim (2006), it was designed to record implementation of exercise done by the patient, start, stop and end session.
- Patient's complications monitoring sheet: Based on side effects Burden Scale (SEBS) by Longman *et al* (1999). This sheet was used to monitor any complications that might be developed to patients during implementation of the exercises. It includes 11 items: dyspnea, bleeding, nausea, vomiting, pain, tachycardia, hypertension, fatigue, headache, fever and feeling of discomfort.

The study tools utilized to collect data in the present study were constructed by the researchers and content validity was done through five experts' opinions. No modification was recommended.

Procedure:

The current study was carried out on three phases, preparatory phase, implementation phase and evaluation phase.

Phase I: Preparatory phase:

- Human rights and ethical permission were obtained to conduct the study. Head of BMT unit gave permission to perform the study. A physician was involved to examine the patient and allow the researchers to start or stop the exercise procedures. Patients were fully informed of the study. The voluntary nature of participation was stressed as well as confidentiality. Consent was obtained from each patient.
- The researchers developed the exercise intervention based on related literature (Dimeo, 1996, Mello *et al*., 2003, Kim and Kim, 2006,). The procedure consisted of four steps 1- Active range of motion for shoulder, elbow, hip, knee and ankle for 10 minutes, 2- Stretching exercises for hamstring, triceps surae and quadriceps muscles for 5 minutes. 3- Resting and relaxing of body and mind for 5 minutes. 4- Walking exercise for 5-10 minutes. Exercises were modified, so that they could be performed in lying, sitting or standing according to the patient's desire, clinical status and tolerance level.
- Wall colored posters and figures illustrating the types of exercises were distributed in BMT unit.

Phase 2: Implementation phase:

A pilot study was carried out by 5 patients to test the clarity, applicability, objectivity and feasibility of the tools to conduct the exercise intervention. Changes and modifications were done accordingly. The subjects included in the pilot study were excluded from the study.

Patients in the BMT unit who met the study criteria were included immediately after their admission. Patient's assessment data sheet was fulfilled as a baseline pre exercise data. During this period, patients were taught how to perform the exercises.

An intensity of one to three sets of 8-15 repetitions and a time of 30 minutes per exercise session were followed as recommended by ACSM (2006). The exercise sessions were done daily for five days/week for four weeks. After one week from the BMT procedure, patients started to perform the exercise session, if the clinical status was stable as stated by their physician and approved by patients and showed by patient's assessment and clinical data sheet. Vital signs were measured before, during and after exercise session to ensure stability during performance of exercise.

The criteria to stop or postponed the exercise session were as follows; feeling of inability to proceed with the exercise, blood pressure over $150/100$, tachycardia or elevated temperature $1^{o}C$ above the baseline or if the patient experienced any discomfort or complaints (Dimeo *et al.*, 1996): During implementation phase patient's observation sheet, patient's complication monitoring sheet was fulfilled to guarantee that the patient is able to perform exercise. Blood samples of total and differential white blood cell count was obtained during day 7, 14, 21, 28 and 56. Data collection took place in the period from December 2008 to October 2009.

Phase 3: Evaluation phase:

The evaluation of the study was measured by improving white blood cell count after implementation and completion of exercise intervention for four weeks and duration of hospitalization. Patients in the control group received the conventional hospital care.

Data analysis:

Data entry, validation and analysis were done with the statistical package for social science version 13.0, the statistical tests used are chi-square test, student T test and paired T test. A value of $p<0.05$ was considered to be statistically significant.

3. Results:

Table 1 shows the characteristics of patients in the study and control groups. There is no significant difference statistically found between patients in the study group and control groups regarding age and sex $p>0.05$. The mean age of patients in study and control groups was 29.0±6.9, 29.2±5.9 respectively, participating patients were 10 men (50%) and 10 women (50%) for each group. The same table shows the mean total white blood cell count before exercise (2.44±1.2, 2.03±1.1) for the study and control groups respectively. The difference is non significant $p>0.05$.

Table 2 reveals the medical diagnosis of patients in the study and control group CML (30%, 35.0%), AML (40.0%, 35.0%), ALL (5.0%, %), A plastic anemia (25.0%, 30%) for the study and control groups respectively the difference in non significant 0>0.05.

Table 3 shows the mean of white blood cell count along the exercise sessions. There is a higher mean of WBCs (2.58±1.1) for patients in the study group after 7 days of exercise compared to patients in the control group (2.06±1.1), the difference is non significant $p>0.1$. The same table shows a higher mean of WBC count (4.34±1.3) for patients in the study group after 14 days of exercise compared to patients in the control group (2.61±1.0), the difference is highly statistically significant $p<0.01$.

There is a higher mean of WBC count (6.13±1.7) among patients in the study group at 21 days of exercise compared to patients in the control group (3.29±1.0), the difference is highly significant $p<0.01$.

The same table illustrates a higher mean of WBC count (9.98±3.1) among patients in the study group at 28 days of exercise compared to patients in the control group (5.23±1.7), the difference is highly significant $p<0.01$. Also, there is a higher mean of WBC count (11.2±2.8) among patients in the study group at 56 days of exercise compared to patients in the control group (6.12±1.4), the difference is highly significant $p<0.01$.

Table 4 reveals comparison between patients in study and control groups regards the mean of neutrophis and lymphocytic count along the exercise sessions. There is no significant difference statistically observed ($p>0.08$) between patients in the study and control groups as regards the mean neutrophils and lymphocytes count before exercise (1.68±0.9, 1.22±0.6) respectively. After exercise sessions at 7 days the results shows a higher mean (1.8±0.9) neutrophil count among patients in the study group compared to patients (1.2±0.6) in the control group, the difference is significant $p<0.04$. There is a higher mean neutrophil count at 14, 21 and 28 days among patients in the study groups compared to patients in the control group, the difference is highly significant ($p<0.01$) and significant $p<0.02$ respectively. There is a higher mean (5.4±2.4) neutrophil count at 56 days among patients in the study group compared to patients in the control group, the difference is non significant $p>0.1$. The same table shows that there is a higher mean (0.82±0.5, 0.83±0.5, 1.1±0.4) of lymphocyte count among

patients in the study group before exercises, at 7 days, 14 days respectively, compared to patients in the control group, the mean are (0.81±0.5, 0.81±0.5, 0.9±0.5) before exercises, at 7 days, 14 days respectively, the difference is non significant p>0.1. There is a higher mean lymphocyte count (1.3±0.6, 2.5±1.0, 3.0±1.0) among patients in the study group at 21, 28, 56 days respectively compared to patients in the control group, the mean are (1.1±0.4, 1.1±0.2, 1.3±0.2) at 21, 28, 56 days respectively, the difference is highly significant p<0.01.

Table 5 reveals comparison between patients in study and control groups as regards the mean monocytes, basophilic and esionphilic count during exercise sessions. There is a higher mean monocytes (0.01±0.02) at 14 days among patients in the study group compared to patients in the control group, the difference is non significant p>0.1. There is a higher mean monocytes (0.2±0.3) of patients in the study group at 21 days, compared to patients in the control group (0.01±0.02), the difference is significant p<0.05. There is a higher mean monocytes (0.7±0.4, 1.0±1.0) of patients in the study group at 28, 56 days respectively, compared to patients in the control group (0.07±0.05, 0.09±0.05), at 28, 56 days respectively, the difference is highly significant p<0.01.

The same table shows that there is a higher mean basophilic count (0.46±0.1, 0.71±0.4, 0.84±0.3) at 21, 28 and 56 days respectively among patients in the study group compared to patients in the control group (0.01±0.02, 0.07±0.04, 0.09±0.03) at 21, 28, 56 days respectively, the difference is highly significant p<0.01.

The same table reveals that there is a higher mean esinophilic count (0.35±0.2, 0.65±0.3, 0.81±0.3) at 21, 28 and 56 days respectively among patients in the study group compared to patients in the control group (0.01±0.02, 0.07±0.04, 0.09±0.03) at 21, 28 and 56 days respectively, the difference is highly significant p<0.01.

Table 6 shows the comparison between patients in two studied groups as regards the mean length of hospital stay after BMT in hospital (in days). There is a lower mean (26.4±7.4) among patients in the study group compared to patients in the control group (76.7±24.7). The difference is highly significant p<0.01.

Table 7 reveals the comparison of percentage improvement in WBC count for patients in two studied group. In comparison to the pre exercise session the major improvement was detected at 56 days (359.0%) followed by 28 days (309.0%) for patients in the study group. For patients in control group received conventional therapy. The major improvement was detected at 56 days as (201%) followed by 28 days (157%).

Tables 3.4.5.6.7 support the study hypothesis which states that the patients with hematological disorders undergoing BMT who will be exposed to exercise intervention (study group) will have improved white blood cell count and reduced duration of hospital stay, compared to the patients in the control group who will not be exposed to exercise intervention.

Table (1): Characteristics of patients in study and control groups.

Age of patients	**Mean±SD**				**t**	**P**
Study group N=20	29.0±6.0				0.07	0.9
Control group N=20	29.2±5.9					
Sex of patients	**Males**		**Women**		**X^2**	**P**
	No.	**%**	**No.**	**%**		
Study group N=20	10	50	10	50	0.001	0.9
Control group N=20	10	50	10	50		

p>0.05 not significant.

Table (2): Comparison between patients in the study and control groups as regards diagnosis before exercise sessions.

Patients	**CML**		**AML**		**ALL**		**Aplastic anemia**		**X^2**	**P**
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**		
Study group N=20	6	30.0	8	40.0	1	5.0	5	25.0	1.2	0.7
Control group N=20	7	35.0	7	35.0	0		6	30.0		

p>0.05 not significant.

-CML=Chronic myeloid leukemia, AML= Acute myeloid leukemia, ALL= Acute lymphoid leukemia.

Table (3): Comparison between patients in the study and control groups as regards the mean WBCs count during exercise sessions.

White blood cell count	Study group Mean±SD	Control group Mean±SD	t	P
Before exercise session	2.44±1.2	2.03±1.1	1.0	0.2
7 days	2.58±1.1	2.06±1.1	1.4	0.1
14 days	4.34±1.3	2.61±1.0	4.4	0.000**
21 days	6.13±1.7	3.29±1.0	6.3	0.000**
28 days	9.98±3.1	5.23±1.7	5.9	0.000**
56 days	11.2±2.8	6.12±1.4	7.0	0.000**

**p<0.01 highly significant

Table (4): Comparison between patients in the study and control groups as regards the mean neutrophil and lymphocytic count before and during the exercise sessions.

	Study group Mean±SD	Control group Mean±SD	t	P
Neutrophil pre exercise sessions	1.68±0.9	1.22±0.6	1.7	0.8
Neutrophil 7 days	1.8±0.9	1.2±0.6	2.0	0.04*
Neutrophil 14 days	3.1±1.2	1.6±0.6	4.6	0.000**
Neutrophil 21 days	3.7±1.1	2.1±0.5	5.2	0.000**
Neutrophil 28 days	5.3±2.2	3.9±1.5	2.3	0.02*
Neutrophil 56 days	5.4±2.4	4.5±1.4	1.4	0.1
Lymphocytes pre exercise sessions	0.82±0.5	0.81±0.5	0.05	0.9
7 days	0.83±0.5	0.81±0.5	0.1	0.9
14 days	1.1±0.4	0.9±0.5	1.3	0.1
21 days	1.3±0.6	1.1±0.4	5.2	0.000**
28 days	2.5±1.0	1.1±0.2	5.8	0.000**
56 days	3.0±1.0	1.3±0.2	7.4	0.000**

*p<0.05 significant **p<0.01 highly significant.

Table (5): Comparison between patients in the study and control groups as regards the mean monocytes, basophilic and esionphilic count during the exercise sessions.

	Study group Mean±SD	Control group Mean±SD	t	P
Monocytes pre exercise sessions	0±0	0±0	--	--
7 days	0±0	0±0	--	--
14 days	0.01±0.02	0±0	1.0	0.3
21 days	0.2±0.3	0.01±0.02	2.4	0.01*
28 days	0.7±0.4	0.07±0.05	7.1	0.000**
56 days	1.0±1.0	0.09±0.05	7.4	0.000**
Basophilic count pre exercise sessions	0±0	0±0	--	--
7 days	0±0	0±0	--	--
14 days	0±0	0±0	--	--
21 days	0.46±0.1	0.01±0.02	13.4	0.000**
28 days	0.71±0.4	0.07±0.04	6.8	0.000**
56 days	0.84±0.3	0.09±0.03	8.4	0.000**
Esinophilic count pre exercise sessions	0±0	0±0	--	--
7 days	0±0	0±0	--	--
14 days	0±0	0±0	--	--
21 days	0.35±0.2	0.01±0.02	5.6	0.000**
28 days	0.65±0.3	0.07±0.04	6.7	0.000**
56 days	0.81±0.3	0.09±0.03	9.2	0.000**

*p<0.05 significant **p<0.01 highly significant.

Table (6): Comparison between patients in the study and control groups as regards the mean length of hospital stay after BMT (in days).

Hospital stay after BMT	Mean±SD	t	P
Patients in study group N=20	26.4±7.4	8.0	0.000**
Patients in control group N=20	76.7±24.7		

**p<0.01 highly significant.

Table (7): Comparison of percentage improvement in WBC count in patients in study and control groups.

	Study group % improvement	Control group % improvement
7 days	5.7	1.4
14 days	77.8	28.5
21 days	151.0	62.0
28 days	309.0	157
56 days	359.0	201

4. Discussion:

Nursing science and research within bone marrow transplantation stated in the early 80s and has been shown to be a useful contribution to obtain and maintain high standards of care (Fliednar, 2002). Preliminary evidence indicates that physical exercise may be an effective strategy for patients with cancer following chemotherapy and bone marrow transplantation (Courneya *et al*., 2000).

Results from several meta-analyses, conducted on exercise and cancer recovery literature, have been published. The results demonstrate evidence findings for a small to moderate effect of exercise intervention such as low intensity aerobics on patient's status. In particular physiologic outcomes as decrease blood pressure, duration of neutropenia, thrombocytopenia, decreased days in hospital and increase white blood cells as well as fitness and vitality following treatment (Stevenson *et al*., 2004, Visovisky and Devorak, 2005, Conn *et al*., 2006, Van Weert *et al*., 2008).

The aim of the present study was to examine the effect of exercise intervention on white blood cell count and duration of hospital stay among patients undergoing allogenic bone marrow transplantation.

At baseline data, no statistical difference was found between patients in the study and control groups, allowing comparability of the two groups. The acceptability rate of 100% of patients in the study group was achieved, indicating that patients were interested in performing physical exercises during hospitalization. This is significant because it was not clear that we would be able to recruit these patients into exercise intervention and effectively retain them along the sessions.

The study findings showed that patients in study group did not experience any form of complication along the exercise sessions. This may be that patient's clinical status was stable before performing the exercise and they choose the position they want. In the same line Elter *et al.* (2009) concluded that physical exercises in patients with severe cytopenia are safe. Jarden *et al.* (2007) stated that exercise intervention for patients undergoing allogenic stem cell transplantation proved to be feasible, safe and well tolerated.

The clinical significance of the study results lies not only in the difference in mean scores between groups, but in the fact that patients were able to safely participate in a 5 days/week program.

The findings of this study showed increase of white blood cell count for patients undergoing BMT in the study group after implementation of exercise program. In the same line Scalzitti and Sternisha (2002) concluded that an exercise program for hospitalized patients following bone marrow transplantation could have a positive effect on white blood cell count and platelets count typically seen after transplantation.

In the same context Dimeo *et al.* (1999) conducted a study for patients with BMT, implemented an exercise program. The authors found that the duration of a white blood cell count below 500,000 g/uL was shorter for the patients in exercise group than for the non training group (6.6±1.5 days vs. 7.6±1.6 days).

Elter *et al.* (2009) stated that patients with critical cytopenia receiving chemotherapy before BMT are at high risk to develop complications such as infection and thus potentially benefit from exercise intervention, explained that high dose chemotherapy induces a "reset" of the haematopoietic and immune system which eventually rebuilds under the constant challenge of exercise.

In contrast to the present study findings Kim and Kim (2005) conducted a study to investigate the effects of a relaxation breathing exercise on anxiety, depression and leukocyte count in patients who underwent allogenic BMT. Patients in exercise group had a greater decrease in anxiety and depression than

did the control group, but the total number of leukocytes did not significant differ between the two groups.

The present study findings reported increase in differential leukocyte count including neutrophils, lymphocytes, monocytes, basophilic and easinophilic count for BMT patients during hospitalization.

This is in agreement with Kim and Kim (2006) who investigated the effect of exercises on lymphocyte count in patients with allogenic BMT during hospitalization. Patients in the exercise group had a mean increase of 40.9 lymphocyte cells/uL and patients in the control group had a mean decrease of 640.7 lymphocyte cells/uL.

In the same line Laperriere *et al.* (1994) concluded that several lymphocytes subpopulations are increased following a 10-week program of aerobic exercise training.

Pederson (2005) stated that natural immunity is influenced by exercise. Physical activity induced increased circulating levels of a number of anti-inflammatory cytokines. The dominant features in the post-exercise period are lymphopenic, neutrophilia and a marked suppressed natural killer cell activity.

In contrast to the present study findings Hayes *et al.* (2003) examined the number and function of lymphocytes and leukocytes; they did not find any significant differences between BMT patients in the study and control groups at the end of exercise program.

In the present study, exercise intervention was stopped after four weeks. Patients might be still hospitalized or discharged according to their clinical status, but they have to come for follow up. Blood samples were taken at day 56. The results showed maintained improved white blood cell count. This could be due to long term effect of exercise or other factors such as improvement of patient's condition, performance of daily living activities, compliance to medication and absence of complication. Most of studies concerning exercises programs for patients undergoing BMT, conducted during hospitalization in short time, and long term effect did not reported as in studies done by Dimeo *et al.* (1997), Kim and Kim (2006).

The present study results showed a highly significant decrease in hospitalization days for patients in the study group received exercise intervention compared to patients in the control group ($p<0.01$). Although, the decision to discharge the patient is made by medical staff based on clinical consideration (exercise intervention outcomes were not included). Therefore, the shorter duration of hospital stay for the patients in the study group may not entirely be an artifact because of subjective decisions made by medical staff.

This study result is supported by Courneya *et al.* (2000) found that physical exercise may be an effective strategy for rehabilitation of cancer patients following high dose chemotherapy and bone marrow transplantation, concluded that exercise intervention during hospitalization correlated with a shorter hospital stay and with most of the quality of life indexes.

Dimeo *et al.* (1997) concluded that exercise program for hospitalized patients following BMT or stem cell transplantation could reduce fatigue and shorten hospital stays and had a positive effect on decrease in the white blood cell count typically seen after transplantation.

The result is in accordance with Dimeo *et al.* (1999) found that the duration of hospitalization was shorter for the BMT patients in exercise group than for the non training group (13.6±2.2 days versus 15.2±3.6 days).

Scalzitti and Sternisha (2002) stated that exercise program for hospitalized patients following BMT could shorten hospital days.

Conclusion:

In view of this study results, it is concluded that the effect of exercise intervention starts to show significant difference at 14 days of exercise implementation which means that the effect of exercise improves the total and differential white blood cell count and reduced hospital stay. Therefore, the study hypothesis that the patients undergoing BMT who, will be exposed to exercise intervention will have improved white blood cell count and reduced duration of hospital stay, compared to the patients in control group who will not be exposed to exercise intervention, was justified.

Recommendations:

According to the results of the current research, the following suggestions are proposed:

- Exercise intervention could be an effective nursing intervention for patients undergoing BMT to improve the suppressed WBC count and reduce hospital stay.
- Communication of the evidence best practice among physicians, nurses and physical therapists will help creation of exercise protocols for patients undergoing BMT and should incorporated into care plans.
- There is a need for randomized controlled trails with larger sample size, conducted across different in and out patient hospital units and to conduct long-term follow up studies to examine the therapeutic sustainability of the applied intervention strategies, patients'

adherence and barriers to conduct exercises after BMT either in hospital or after discharge.
- Future studies should also examine what kind of exercise intervention (aerobic vs. resistance vs. combined) is the most effective for BMT patients, and a cost-benefit analysis of the implementation of exercise in the view of reduced hospital stay.

Implications for nursing practice:

Nurses can play a critical role in encouraging patients to start or maintain exercise. Monitoring patients' provide information and counseling are key components of nursing practice. Nurses must continue to expand the literature on evidence guidelines for exercise in oncology populations and to recommend and participate in exercise protocols developed for patients with cancer and different treatment modalities as bone marrow transplantation.

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References:

1. American College of Sports Medicine (ACSM), 2006. ACSM's guidelines for exercise testing and prescription (7th Ed.). Philadelphia: Lippincott Williams & Wilkins.
2. Coleman, E.A., Coon, S., Hall-Barrow, J., Richards, K., Gaylor, D., Stewart, B., 2003. Feasibility of exercise during treatment for multiple myeloma. Cancer Nursing, 26: 410-419.
3. Conn, V.S., Hafdahl, A.R., Porock, D.C., McDanial, R., Nielsen, P.J., 2006. A meta-analysis of exercise interventions among people treated for cancer. Support Care Cancer, 14: 699-712.
4. Courneya, K.S., Keats, M.R., Turner, A.R., 2000. Physical exercise and quality of life in cancer patients following high dose chemotherapy and autologous bone marrow transplantation. Psycho oncology, 9: 127-136.
5. Courneya, K.S. and Friedenreich, C.M., 2007. Physical activity and cancer control. Seminars in Oncology Nursing, 23 (4): 242, 252.
6. Defor, T.E., Burns, L.J., Gold, E.M., Weisdorf, D.J., 2007. A randomized trial of the effect of a walking regimen on the functional status of 100 adult alloegnic donor hematopoietic cell transplant patients. Biology of Blood and Bone Marrow Transplantation, 13: 948-955.
7. Dimeo, F. Bertz, H., Finke, J., Fetscher, S., Mertelsmann, R., Keul, Z., 1996. An aerobic exercise program for patients with hematological malignancies after bone marrow transplantation. Bone Marrow Transplantation, 18: 1157-1160.
8. Dimeo, F.C., Tilmann, M.H., Bertz, H., 1997. Aerobic exercise in the rehabilitation of cancer patients after high dose chemotherapy and autologous peripheral stem cell transplantation. Cancer, 79: 1717, 1722.
9. Dimeo, F., Stieglitz, R., Novelli-Fischer, U., Fetscher, S., Keul, J., 1999. Effects of physical activity on the fatigue and psychologic status of cancer patients during chemotherapy. Cancer, 85 (10): 2273-2277.
10. Elter, T., Stipanov, M., Heuser, E., Von Bergwelt-Baildon, M., Bloch, W., Hallek, M., Baumann, F., 2009. Is physical exercise possible in patients with critical cytopenia undergoing intensive chemotherapy for acute leukemia or aggressive lymphoma? International Journal of Hematology, 90: 199-204.
11. Fliedner, M., 2002. Research within the field of blood and marrow transplantation nursing. How can it contribute to higher quality of care? International Journal of Hematology, 76: 289-291.
12. Galvao, D.A.; Nasaka, K., Taaffe, D.R., Peake, J., Spry, N., Suzuki, K., 2008. Endocrine and immune responses to resistance training in prostate cancer patients. Cancer Prostatic Diseases, 11 (12): 160-165.
13. Goldsby, R; Kindt, TJ; Osborne, BA; Janis, K,. 2003. immunology 5th edition. New York: W. H. Freeman company.
14. Gladson, B., 2006. Pharmacology for physical therapists. Saunders Elsevier, st Louis, pp. 417-444.
15. Hayes, S.C., Rowbattom, D., Davis, P.S., Parker, T.W., Bashford, J., 2003. Immunological changes after cancer treatment and participation in an exercise program. Medical Science Sports and Exercise, 35: 2-9.
16. Hayes, S.C., Davis, P.S., Paker, T.W., Bashford, J., Green, A., 2004. Role of a mixed type, moderate intensity exercise programmme after peripheral blood stem cell transplantation. British Journal of Sports Medicine, 38: 304-309.
17. Hays, S. and Newman, B., 2006. Exercise in cancer recovery: an overview of the evidence. Cancer Forum, 30 (1): 13-17.
18. Hayes, S.C., Spence, R.R., Galvao, D.A., Newton, R.U., 2009. Australian association for exercise and sport science position stand: optimizing cancer outcomes through exercise. Journal of Science and Medicine, 12: 428-434.
19. Hilton, A., 1996. The effect of strenuous exercise, calorie deficiency and sleep deprivation on white blood cells, plasma immunoglobulins and cytokines. Scandinavian Journal of Immunology, 43 (2): 228-235.
20. Jarden, M., Hovgaard, D., Boesen, E., Quist, M., Adamsen, L., 2007. Pilot study of a multimodel

intervention: mixed-type exercise and psycho education in patients undergoing allogenic stem cell transplantation. Bone Marrow Transplantation, 40: 793-800.
21. Kim, S.D. and Kim, H.S., 2005. Effects of a relaxation breathing exercise on anxiety, depression and leukocyte in hemopoietic stem cell transplantation patients. Circulation, 81: 1550-1559.
22. Kim, S.D. and Kim, H.S., 2006. A series of bed exercises to improve lymphocyte count in allogenic bone marrow transplantation patients. European Journal of Cancer Care, 15: 453-457.
23. Laperriere, A., Antoni, M.H., Ironson, G., Perry, A., McCabe, P., Klimas, N., Helder, L., 1994. Effects of aerobic exercise training on lymphocyte subpopulations. International Journal of Sports Medicine, 15: S127-S130.
24. Lee, S.J., Loberiza, F., Rizzo, J.D., Soiffer, R., Antin, J., Weeks, J.C., 2005. Routine screening for psychosocial following hematopoietic stem cell transplantation. Bone Marrow Transplantation, 35: 77-83.
25. Locascilli, A. Onteo, R., Bacigalupo., 2007. Outcome of Patients with Acquired A plastic Anemia given First line Bone Marrow Transplantation or immuno-Suppressive Treatment in the last decade. Hematologica, 92 (1): 8-11.
26. Longman, A.J., Braden, L.J., Mishel, M.H., 1999. Pattern of association overtime of side effects burden, self-help and self-care in women with breast cancer. Oncology Nursing Forum, 24(9): 1555-1560.
27. Mackinnon, L.T., 1992. Exercise and immunology human kinetics books: Champaign, IL.
28. Mello, M, Tanaka, C., Dulley, F.L., 2003. Effects of an exercise program on muscle performance in patients undergoing allogenic bone marrow transplantation. Bone Marrow Transplant, 32 (7): 723-728.
29. Menoni, E. and Ridolfi, A., 2008. Distress, Coping and quality of life in patients who underwent a bone marrow transplantation. Rivista Di Psciologia Clinica, 2: 205-217.
30. Newton, R.U. and Galvao, D.A., 2008. Exercise in prevention and management of cancer. Current treatment options in oncology DOI 10. 1007/S11864-008-0065-1.
31. Nieman, D.C., 2000. Is infection risk linked to exercise workload? Med Sci Sports Exerc, 32(7 suppl): S406-S411.
32. Parham, P. 2005. The immune system, Garland Science Publishing, New York.
33. Pedersen, B.K., 2005. Natural immunity-Effect of exercise. Neuroimmune Biology, 5: 263-288.
34. Scalzitti, D.A. and Sternisha, C., 2002. Does exercise during hospitalization after stem cell transplantation decrease reports of fatigue and reduce the duration of the hospital stay. Physical Therapy, 82(7): 716-721.
35. Schulz-Kindermann, F., Ramm, G., Zander, A., Hasenbring, M., 2002. The role of biomedical and psychosocial factors for the prediction of pain and distress in patients undergoing high-dose therapy and BMT/PBSCT. Bone Marrow Transplant, 29 (4): 341-351.
36. Stevinson, C., Lawlor, D.A., Fox, K.R., 2004. Exercise interventions for cancer patients: Systemic review of controlled trails. Cancer Causes Control, 15: 1035-1056.
37. Stevinson, C. and Fox, K.R., 2005. Role of exercise for cancer rehabilitation in UK hospitals: A survey of oncology nurses. European Journal of Cancer Care, 14: 63-69.
38. Van Weert, E., Hoekstra-Weebers, J., May, A.M., Korstzens, I., Ros, W.J., Van Dar, C.P., 2008. The development of an evidence-based physical self-management rehabilitation programme for cancer survivors. Patient Education Counseling, 71: 169-190.
39. Wiskemann, J. and Huber, G., 2008. Physical exercise as adjuvant therapy for patients undergoing hematopoietic stem cell transplantation. Bone Marrow Transplantation, 41: 4, 321-329.
40. Wyle, A., 1997. Eight weeks to optimum Health. New York: Alfred A. Knopf.
41. Dimeo, F., 2000. Aerobic exercise following bone marrow transplantation. Rehabilitation oncology, http://findarticles.com/p/ articles/mi-qa3946/is-200001/i-n8895321/accessed 28/04/2009
42. Visovsky, C., Dvorak, C., 2005. Exercise and cancer recovery. Online journal of Issues in Nursing 10(2). http://www.medscape.com/viewartice/506844accessed11/04/2010
43. Young-McCaughan, S., 2006. Exercise in rehabilitation from cancer. Medical surgical nursing http://findarticles.com/p/articles/mi-mofss/is-615/ai_n17215963/?tag=contencoll(accessed 28/4/2009).

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