The Relation between Nutritional Status and Healing Time for Patients Undergoing Hematopoietic Stem Cells Transplantation Sample

Soheir Weheida[1], Salwa El-Badry[2*], Asmaa Rizk[3]

[1] Professor, Medical Surgical Nursing Department, Faculty of Nursing, Alexandria University, Egypt
[2]Assistant Professor, Medical Surgical Nursing Department, Faculty of Nursing, Alexandria University, Egypt
[3]Assitant Lecturer, Medical Surgical Nursing Department, Faculty of Nursing, Alexandria University, Egypt

[2*]Corresponding Author: Dr. Salwa El-Badry

Abstract— Background: *Hematopoietic stem cell transplantation is considered a lifesaving procedure for many hematologic and non-hematologic malignancies. Multiple factors affect transplantation outcome as nutritional status of the patient either over nourished or undernourished. Malnutrition prior to transplant has been reported as a negative prognostic factor following Hematopoietic stem cell transplantation. A recent meta-analysis confirmed that obese recipient has increased risk of acute graft versus host disease and may have increased mortality rates.* ***Aim****: Determine the relation between nutritional status and healing time for patients undergoing hematopoietic stem cell transplantation.* ***Setting:*** *The study was conducted at Al Mouwasat University Hospital, Alexandria University and Nasser Institute Hospital, Cairo.* ***Subjects:*** *The study was conducted on a purposive sample of 40 patients who necessitate hematopoietic stem cell transplantation.* ***Tools****: Two tools were used. Tool I: Socio demographic and clinical data of patients submitted to hematopoietic stem cells transplantation, structured interview schedule and Tool II: Patient's nutritional assessment record prior to hematopoietic stem cells transplantation.* ***Results****: The three quarters of patients were either overweight or obese pre transplantation, the underweight patients had the longest engraftment time and longest hospitalization, and it was observed that the more the body mass index (BMI) and body fat percent, the less time for engraftment.* ***Conclusion and Recommendations****: it is necessary to initiate nutritional assessment and follow up for those patients to prevent malnutrition and to protect the borderline patients to become negatively malnourished and consequently affecting healing time negatively. Moreover, despite the obesity is a risk factor for graft versus host disease and transplantation complications, it is not dangerous as malnutrition in occurrence of late engraftment.*

Keywords— "Engraftment", "Hematopoietic Stem Cell Transplantation", "Malnutrition", "Nutritional Status", "Obesity"

I. INTRODUCTION

Regenerative medicine, the most recent and emerging branch of medical science, deals with functional restoration of specific tissue and/ or organ of the patient of severe injuries or chronic disease conditions, in the state where bodies own regenerative responses don't suffice (1). Stem cells are defined as biological cells that have capacity to self-renew as well as the ability to generate differentiated cells, they can generate daughter cells identical to their mother (self-renewal) as well as produce progeny with more restricted potential

(differentiated cells) [2]. Hematopoietic stem cells: give rise to all the types of blood cells: they are rare cells of mesodermal origin residing in the adult mammalian bone marrow (one hematopoietic cell can be found in approximately 10^4 of bone marrow nucleated cells). Hematopoietic stem cells are characterized by the ability of self-renewal, differentiation to all mature blood lineages and mobilization. The myeloid lineage further gives rise to erythrocytes, monocytes and macrophages, neutrophils, basophils, eosinophils, megakaryocytes, and dendritic cells. The lymphoid lineage produces T- and B-lymphocytes and Natural Killer cells [3, 4].

Hematopoietic stem cells transplantation is the most important application of hematopoietic stem cells today. They are progenitor cells (specialized cells that originate from stem cell and developed into more specific "target" cells) with repopulating capacity and the potential to sustain long term hematopoiesis within one person or from one person to another, in a dose that is sufficient to restitute hematopoiesis in all lineages [5]. Hematopoietic stem cell transplantation may be 1. Autologous, it means that the donor cells used for the procedure are from the patient himself, the stem cell source in autologous type can be either mobilized peripheral blood stem cells or bone marrow. 2. Allogeneic, which refers to a cell donor other than the patient [6].

Sources of stem cells in allogeneic type include bone marrow, peripheral blood, or umbilical cord blood. Using stem cells from either a family member or an unrelated donor. It may be from 1.1: Unrelated donor found using a donor registry. 1.2: Related donor as following: Sibling donor: Human Leucocyte Antigen matched brother or sister, syngeneic from an identical twin and haploidentical: half-matched family member [6].

In Egypt, hematopoietic stem cell transplantation program started 1989 on narrow scale. Transplant rate increased dramatically with opening Stem Cell Transplant Unit at Nasser Institute, the total number of transplants performed till June 2007 is 1362; 80% of cases allo and 20% auto [7]. From 2010 till May 2017, the number of transplants performed at Nasser Institute about 1220 cases [8]. Hematopoietic stem cells transplantation procedure is indicated for multiple diseases: 1. leukemias as acute myeloid leukemia. 2. Lymphoid malignancies as diffuse large B-cell lymphoma. 3. Multiple myeloma. 4. Nonmalignant hematologic diseases as acquired severe aplastic anaemia. 4. Solid tumor as breast carcinoma. 5. Autoimmune diseases as systemic sclerosis [9].

The main steps of hematopoietic stem cell transplantation are: 1. finding a donor. 2. Injection of mobilization agent. 3. Collection of mobilized stem cells from the blood using apheresis machine. 4. Preparation for storage in infusion bags. 5. Cryopreservation of stem cells. 6. Administration of preparative regimen to kill any remaining cancer cells. 7. Stem cell transplantation into the blood stream. 8. Engraftment and recovery: engraftment is defined as an absolute neutrophil count (ANC) greater than 500 cells/μL when three consecutive laboratory values obtained on different days show ANC ≥500/μL with no subsequent decline. Platelet engraftment is defined as an unsupported platelet count >20000/μL[6].

Bone marrow transplant has a dramatic effect on the recipient, affecting protein, energy, and micronutrient metabolism. Negative nitrogen balance is common in bone marrow transplant patients as a consequence of both intestinal losses with diarrhea and catabolic effects on skeletal muscle initially exerted by the underlying disease, then by conditioning regimens, and subsequently by possible BMT complications such as sepsis and graft versus host disease [10]. Conditioning regimens used for hematopoietic stem cell transplantation have severe effects on the gastrointestinal tract. Patients experience a reduced oral intake due to one or more of the following: anorexia, nausea, vomiting, diarrhea, mucositis, and taste changes and in many cases, a pre-existing aversion to ‘hospital food’. The prolonged

suboptimal oral intake can last up to 2–3 weeks after hematopoietic stem cell transplantation. As severe malnutrition can develop rapidly in the absence of nutritional support, determining which patients are malnourished prior to transplant enables appropriate nutrition support to be initiated [(11)].

The patient's baseline nutritional status is highly important and the alteration of the pre transplantation nutritional status is a negative prognostic factor for the evolution of these patients. In fact, well-nourished patients require less time, in general, for the graft to prove effective [(12)]. The comprehensive analysis of nutritional status and its relationship to clinical outcomes has not been done. Cancer-related cachexia is highly associated with reduced survival and non-relapse mortality for underweight patients at hematopoietic stem cell transplantation greater than healthy-weight patients [(13)]. In overweight and obese groups, the risk of non-relapse mortality due to graft versus host disease or infection was higher than that in normal BMI groups. The authors postulated that the exposure of donor immune cells to the proinflammatory immune environment in obese patients altered functional status of the donor immune cells, increasing the risk of graft versus host disease related death. Obesity also is known to alter the pharmacokinetics of cancer chemotherapeutics [(14)].

It seems clear, however, that obesity results in adverse outcomes in the allogeneic allogenic hematopoietic cell transplantation setting and should be incorporated into the risk-benefit assessment in patients being considered for the transplantation procedure. Conversely, in the setting of autologous hematopoietic cell transplantation, they appear to have equivalent outcomes. The impact of obesity on transplant outcomes remains controversial [(14)]. Some studies have identified a variety of risk factors, such as disease stage at the time of transplant, donor types, stem cell sources and age that can have some negative influences on the outcomes of hematopoietic cell transplantation. Regarding body weight, both obesity and being underweight have been considered risk factors for complications in bone marrow transplant patients. In some studies, even though obese patients had a poorer outcome, they showed a significant shorter time to the engraftment as a better outcome [(15)].

Certain studies showed delay of granulocyte engraftment time and incidence of more infection in obese versus non-obese acute myeloid leukemia auto grafted patients. They also reported that obese patients had lower disease free survival and overall survival in comparison with non-obese patients. Other studies showed that BMI had no effect on time to granulocyte engraftment, transfusions, and acute or chronic graft versus host disease among patients with hematologic malignancies undergoing allogeneic stem cell transplantation, but low body mass index was correlated with an increased transplant- related mortality, decreased survival and relapse-free survival after allogeneic stem cell transplantation [(15)]. Initial and serial assessment is necessary for all patients undergoing hematopoietic cell transplantation. Frequent, ongoing nutrition assessment allows for a rapid response to sudden changes in clinical status [(16)].

Nurses are responsible for performing comprehensive nutritional assessment, development of short- and long-term nutritional goals planning nutritional interventions and systematic reassessment of nutritional status in clinical setting with nutritional specialist even in absence of nutritional specialist [(17, 18, 19)]. Nurses should be equipped with adequate assessment tools that triage patient’s nutritional status at admission and on regular basis along transplantation. Moreover, they should be able to assess severity of gastrointestinal symptoms, determine their grades and manage them to overcome significant weight loss that affect quality of life and outcome of transplantation [(19, 20)].

Nurses should be aware of food handling behaviors and practices to control food borne illnesses [(21)]. Also, bottled water can be consumed if it conforms to regional standards (e.g., the FDA for the United States) and has been processed to remove cryptosporidium

(crypto) by 1 of 3 processes: reverse osmosis, distillation, or 1-micro meter particulate absolute filtration [22]. Traditional hospital food service with set mealtimes, limited food choices, and advance menu selection may fail to meet the dietary needs of the majority of hematopoietic stem cell transplantation (HSCT) patients. Key points include sufficient trained stuff to help meal selection, a satellite kitchen on the HSCT or oncology unit, availability of foods and beverages typically requested and a way of accurately assessing daily oral intake [23]. For patients in hospital, food preparation and service should be carried out in a kitchen within the unit where patients are treated. This has several advantages: Food can be provided as needed rather than at fixed meal times, thus encouraging more frequent consumption of foods and liquids and hence better nutrient intake. Also, Food intake is more easily monitored by nurses [12].

Hematopoietic cell transplantation recipients experience numerous problems post transplantation that interfere with adequate nutrient intake and nutritional status and include oral and gastrointestinal sequelae and organ or tissue damage resulting in hepatic, renal, or pulmonary impairment; iron overload and glucocorticoid-induced hyperglycemia are also frequently observed. Moreover, graft versus host disease has its own unique nutritional challenges that impact nutritional status. So, continuous nutritional monitoring and intervention post transplantation is very crucial, especially, due to increasing in stress factor and metabolic needs [24]. The nutritional assessment should include laboratory and anthropometric data, as well as a complete diet history, medical history, gastrointestinal review of symptoms and physical examination for signs of malnutrition, also psychiatric review of symptoms as depression and anxiety [25].

Physical signs of malnutrition and biochemical markers weren't indicator for nutritional status during transplantation period due to their multifactorial disturbances affecting them [16]. Body composition analysis has two unique advantages when measuring body composition. First, it provides information that cannot be discovered from a physical examination. For example, a physical examination is of limited value in identifying whether weight loss reflects a loss of mineral, muscle, fat, fluids or a combination of these, it provides separate measure for each of body composition constituent. Second, changes in body composition that can be discovered by physical examination can be detected earlier using bioelectrical impedance analysis [26].

Three sets of criteria for malnutrition in hospitalized patient, the Dutch definition for malnutrition, the European Society for Parenteral and Enteral Nutrition (ESPEN) diagnostic criteria for malnutrition and the ESPEN diagnostic criteria for malnutrition without fat free mass index (FFMI). There is a recommendation for bioelectrical impedance analysis (BIA) measurement as a means to avoid the misdiagnosis of malnourished patients. Since BIA is a simple measurement technique, the measurement is not time-consuming, and the devices are becoming more affordable, there is advocation to implementation of measurements of body composition in the assessment of malnutrition, so ESPEN new diagnostic criteria of malnutrition is important [27].

II. MATERIALS AND METHOD

Materials

Research design:

A descriptive research design was utilized in this study.

Setting:

The study was conducted at 2 settings:

- **First**, Bone Marrow Transplant Unit, Al Mouwasat University Hospital, Alexandria. It was consisted of 4 patient capsules, each for one patient, receiving children and adult

patients, 2 rooms for chemotherapy administration, one room for stem cells collection by apheresis machine, stem cells preservation bank, preparatory area contains 2 beds, room for food and linens autoclaving and meeting room for unit staff.

- **Second**, Bone Marrow Transplant Unit, Nasser Institute hospital for treatment and research, Cairo affiliated to the Ministry of Health. It consists of 20 capsules, each for one patient, receiving children and adult patients, one room for stem cells collection by apheresis machine, stem cells preservation bank**,** room for food and linens autoclaving, secretary room and doctor**'**s office.

Subjects:

A convenient sample of 40 patients who necessitate hematopoietic stem cell transplantation admitted to the above mentioned settings. The patients were chosen based on the following criteria:

Adult patient diagnosed with hematologic malignancy or non-hematologic malignancy that necessitate stem cells transplantation either allogeneic or autologous.

Tools for data collection:

Tool I: Socio Demographic and Clinical Data of Patients Submitted to Hematopoietic Stem Cells Transplantation, Structured Interview Schedule: This tool was developed by the researcher after reviewing related literature [16, 26- 28] to identify characteristics of patients and baseline clinical data, it included two parts:

Part 1:Patient's Sociodemographic Characteristics: This part included data such as; age, gender, residence, level of education, income, occupation.

Part II: Patients' Clinical Data: This part included data such as; Diagnosis, source of transplant, length of hospital stay, engraftment period, present health history and past health history.

Tool II: Patient's nutritional assessment record prior to hematopoietic stem cells transplantation

This tool was developed by the researcher after reviewing the related literature [24, 29- 48- 56] to assess nutritional status of patients' pre hematopoietic stem cells transplantation, it included 5 parts:

Part I: **Anthropometric measurements**: This part was used to assess anthropometric parameters of patients, it included: weight, height, body mass index and body composition measurements: fat percent, water percent, muscle percent and bone mass. Obtained data of anthropometric measurements was compared against normal values.

Part II: Biochemical markers assessment: This part was used to assess biochemical indicators of nutritional status, it included: serum albumin, total proteins, fasting blood sugar, complete blood count (CBC), serum potassium, serum sodium, serum magnesium, serum calcium, C reactive protein (CRP), uric acid, total bilirubin, serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvate transaminase (SGPT) and creatinine. Obtained data of laboratory investigations was compared against normal values of hospital laboratory.

Part III: Physical signs of malnutrition: This part was used to assess signs of malnutrition included general appearance, hair, face, eyes, lips, tongue, gums, teeth, skin, nails, glands and muscles. Obtained data was scored as: (1) score was given for abnormal finding and (0) score was given for normal finding.

Part IV: Dietary history and dietary intake: This part was used to assess dietary history and dietary intake at hospital per meal using food intake record to identify total caloric intake and macronutrients deficiencies

- **Dietary history**: it included: eating pattern, usual weight, recent weight change, recent history of gastrointestinal manifestations, food allergy, nutritional supplement, self-care behavior related to food (who prepares meals? usual method of cooking, type of fat used in cooking), usual places of eating and alcohol or illegal drug use.
- **Dietary intake:** It was assessed using dietary intake record for three separate days pre transplantation (first day: second day at hospital, second day: mid-way from admission until transplant, third day: the day pre transplantation) and it included type and amount of food and fluid taken per meal, method of cooking and nutritional supplement, also food analysis for amount of protein, carbohydrate, lipid.

Egyptian food composition tables 2006 were used to analyze the food consumed by the patient to get the dietary composition of macronutrients and compare them to the dietary reference intake (DRI) [24, 56] to assess the percent adequacy

Part V: Caloric requirement assessment: This part was used to assess caloric requirement for hospitalized patients during the pre-transplantation period. The calculations of predicted total energy expenditure (TEE) are derived using the Harris-Benedict equation multiplied by an activity factor (1.2) and stress factor (1.1- 1.4) for patients prepared for bone marrow transplant [31, 48].

Method

- An approval from the ethical committee, Faculty of Nursing, Alexandria University was obtained.
- Written approval to carry out the study was submitted from the Faculty of Nursing to the following areas to collect data and permission was obtained after explaining of the purpose of the study.
- Validity testing: All tools were submitted to five experts in the field of medical surgical nursing, nutrition and the field of hematology for content validity and the necessary modifications were done.
- Reliability testing: Reliability of the tools was tested using Cronbach's alpha. Reliability coefficient for tool I was 0.76, tool II was 0.91.
- A pilot study was conducted on five patients before beginning the study to test the feasibility and applicability of the different items of the tools and to establish practical and comprehensive way for obtaining the necessary data. Pilot study results were excluded from the actual study.
- Data collection was started and continued for ten months from the two settings at the same period whenever the patient was admitted.

- **Initial phase**: was conducted on the first 2 days of admission, using tool (1) to collect baseline data regarding sociodemographic and clinical data of the patient, using tool (2) for nutrition assessment except part V.
- This patient interview took about 1 hour: about half an hour outside patient's capsule communicating with the patient about medical history, social data and recent nutritional assessment from a small window then about 30 minutes to wear Personal Protective Equipment and entering inside capsule for anthropometric measurement and accurate observation of physical signs of malnutrition.
- Some clinical data, conditioning protocol and laboratory investigations were taken from patient's medical and nursing records, it took about 20 minutes

- All equipment that used during data collection inside the capsule was disinfected according to hospital policy.
- **Second phase**: Calculate energy requirements for the patient using tool 2-part V
- **Third phase** the day pre transplantation: It was conducted one day or day pre transplant using tool 2 except part V. It took about 90 minutes for each patient**.** It included measurements of nutritional parameters inside patient's capsule. Second reading to medical and nursing records for laboratory investigations data
- **Fourth phase** pre discharge: it included measurements of anthropometric parameters inside patient's capsule using tool 2. It took about 20 minutes
- The fourth phase was performed on three quarters of study sample only, because there were some limitations pre discharges as: patient's refuse to last measurement, die or entered at psychosis.
- There are some clinical data collected from the patient medical record after discharge as length of hospital stay and engraftment period

Ethical considerations were considered:

- Written informed consent was obtained from each patient after explaining of the purpose of the study.
- Patient's privacy and confidentiality of the data was respected.
- Patient's right to withdraw at any time of research participation was considered and respected.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. [57] Significance of the obtained results was judged at the 5% level.

The following statistical measures were used [58]**:**

A. Descriptive statistics.

1- Frequency and percentage, used for describing and summarizing qualitative data

2- Arithmetic mean (x) standard deviations (SD) are used as measure of central tendency and dispersion respectively for normally distributed quantitative data.

B. Analytical statistics: They were used for comparing between pretransplant and pre discharge measurements, the following tests were used:

- Quantitative data:
  - Parametric: One way repeated measures ANOVA and paired t test.
  - Non-parametric: Wilcoxon Signed Rank test.

III. RESULTS

Table (1): presents distribution of patients undergoing hematopoietic stem cell transplantation according to their socio-demographic characteristics. More than one third of studied patients were in age group of 20- 30 years, while for gender; half of studied patients were males. Moreover, the majority of studied patients were married and for level of education, more than two thirds of the studied patients were not on university level. Half of studied patients were technical workers (Ceramic worker- paints worker- carpenter- mechanic- worker at clothes factory- worker at iron and steel factory- driver- decoration engineer). As for income, around half of studied patients were at income level 500- 1000 pounds while for residence, around two thirds of studied patients were from rural areas.

Table (2): presents distribution of studied patients according to their clinical data. The highest percentage of the studied patients were diagnosed with acute myeloid leukemia, while for the source of transplantation, all the studied patients received stem cells from the peripheral blood whether autologous or allogeneic transplant. The mean days to reach absolute neutrophil count (ANC) >500 was (11.0±1.73) days for autologous and (13.57±2.48) for allogenic transplantation, while the mean days to reach ANC > 1000 was (12.0±7.0) days for autologous and (16.0±3.92) days for allogenic transplant and the mean length of hospital stay for the studied patients was (34.65) days.

Table (3): presents distribution of the studied patients according to their body mass index measurements at admission, the day pre transplantation and predischarge. The mean weight on admission was (84.00 ± 23.27) kg, while pre transplantation (81.85 ± 23.09) kg and it was (78.27 ± 22.57) kg pre discharge, with statistically significant differences between them (P <0.001). Regarding body mass index, the table illustrated that (42.5%) of studied patients were obese with BMI ≥ 30 at admission. The mean of BMI on admission was (29.98 ± 7.44), while (29.23 ± 7.47) the day pre transplant and it was (27.67 ± 7.73) pre discharge, with statistically significant differences between them (P <0.001).

Table (4): presents distribution of the studied patients according to their body composition measurements at admission, the day pre transplant and pre discharge. More than two thirds (67.5%) of studied patients had excess body fat percent on admission, with the mean on admission (30.34 ± 8.39) while pre transplant was (29.21 ± 8.91) and pre discharge it was (25.71 ± 9.63), with statistically significant differences between them P (0.002& <0.001) respectively. The table illustrated that the mean water percentage on admission was (43.88 ± 6.33) while pre transplant was (45.11 ± 7.06) and pre discharge it was (47.69 ± 8.33), with statistical significant differences between them P (0.002&<0.001) respectively. The study revealed that the mean muscle percent pre transplant was (33.15 ± 5.27) while pre discharge was (34.93 ± 6.39), with statistical significant differences between them (P<0.001). The study showed that the mean bone mass pre transplant was (11.64 ± 2.08) while pre discharge was (11.45 ± 1.87), with statistical significant differences between them (P <0.001).

Table (1): Percentage distribution of patients undergoing hematopoietic stem cell transplantation according to their socio-demographic characteristics.

Socio-demographic data	Studied patients (n=40)	
	No	%
Age (years)		
▪ 20-	16	40.0
▪ 30-	14	35.0
▪ 40-	7	17.5
▪ 50- 60	3	7.5
Min. – Max. Mean ± SD. Median	20 – 56 34.05 ± 9.31 32.0	
Gender		
▪ Male	20	50.0
▪ Female	20	50.0
Marital status		

▪ Single	7	17.5
▪ Married	33	82.5
Level of education		
▪ Illiterate	6	15.0
▪ Primary	4	10.0
▪ Preparatory	14	35.0
▪ Diplom	11	27.5
▪ Universal education	5	12.5
Occupation		
▪ Clerk work	4	10.0
▪ Technical work	9	22.5
▪ Manual work	7	17.5
▪ Not working	2	5.0
▪ Others (house wife)	18	45.0
Average income (pounds)		
▪ < 500	9	22.5
▪ 500 –	16	40.0
▪ ≥ 1000	15	37.5
Residence		
▪ Urban	16	40.0
▪ Rural	24	60.0

Table (2): Percentage distribution of studied patients according to their clinical data

Clinical data	Studied patients (n=40)	
	No	%
Diagnosis		
▪ Acute myeloid leukemia	19	47.5
▪ Chronic myeloid leukemia	6	15.0
▪ Acute lymphocytic leukemia	4	10.0
▪ Hodgkin's lymphoma	1	2.5
▪ Severe aplastic anemia	4	10.0
▪ Multiple myeloma	3	7.5
▪ Myelo dysplastic syndrome	2	5.0
▪ Others (Osteomyelofibrosis)	1	2.5
Source of transplant		
▪ Bone marrow	0	0.0
▪ Peripheral blood	40.0	100.0
Number of days to reach ANC> 500		
▪ Autologous transplantation		
Min. – Max.	10-13	
Mean ± SD.	11.0±1.73	
Median	10.0	
▪ Allogenic transplantation		
Min. – Max.	10-19	
Mean ± SD.	13.57±2.48	

Median	13.0
Number of days to reach ANC> 1000	
▪ Autologous transplantation	
Min. – Max.	10-15
Mean ± SD.	12.0±7.0
Median	11.0
▪ Allogenic transplantation	
Min. – Max.	10-28
Mean ± SD.	16.0±3.92
Median	16.0
Length of hospital stay	
Min. – Max.	21 – 45
Mean ± SD.	34.65 ± 5.57
Median	34.5

Table (3): Distribution of the studied patients according to their body mass index measurements at three different intervals (at admission, pre transplant and pre discharge)

Items	On admission		The day pre transplant		Pre discharge	
	No	%	No.	%	No.	%
Weight (Kg)						
Min. – Max.	51.0 – 146.0		47.7 – 144.5		47.1 – 140.5	
Mean ± SD.	84.00 ± 23.27		81.85 ± 23.09		78.27 ± 22.57	
Median	79.4		76.4		73.0	
P			<0.001*		<0.001*	
Height (meter)						
Min. – Max.						
Mean ± SD.			146.0 – 187.0			
Median			167.0 ± 9.78			
			165.5			
BMI (kg/ m^2)						
< 18.5	0	0.0	2	5.0	4	13.8
18.5-24.99	8	20.0	7	17.5	6	20.8
25-29.99	15	37.5	15	37.5	9	31.0
30-34.99	9	22.5	10	25.0	7	24.1
35-39.99	4	10.0	2	5.0	0	0.0
≥ 40	4	10.0	4	10.0	3	10.3
Min. – Max.	19.13 – 51.17		18.30 – 50.0		16.60 – 48.82	
Mean ± SD.	29.98 ± 7.44		29.23 ± 7.47		27.67 ± 7.73	
Median	28.73		27.89		26.59	
P			<0.001*		<0.001*	
Total	40	100.0	40	100.0	29	100.0

p: p value for paired t-test for comparing the basal value with each of the other values.
*: Statistically significant at $p \leq 0.05$

Table (4): Distribution of the studied patients according to their body composition measurements at three different intervals (at admission, pre transplant and pre discharge)

Body composition measurements	On admission		The day pre transplant		Pre discharge	
	No	%	No.	%	No.	%
Body fat percent %						
Minimal	0	0.0	0	0.0	4	13.8
Recommended	13	32.5	15	37.5	10	34.5
Over fat	9	22.5	7	17.5	10	34.5
Obese	18	45.0	18	35.0	5	17.2
Min. – Max.	12.0 – 43.7		9.4 – 42.7		6.7 – 41.7	
Mean ± SD.	30.34 ± 8.39		29.21 ± 8.91		25.71 ± 9.63	
Median	31.95		30.65		26.5	
P			0.002*		<0.001*	
Water percent %						
Min. – Max.	36.0 – 57.0		36.0 – 61.0		35.0 – 65.5	
Mean ± SD.	43.88 ± 6.33		45.11 ± 7.06		47.69 ± 8.33	
Median	43.05		45.0		48.5	
P			0.002*		<0.001*	
Muscle percent %						
Min. – Max.	27.0 – 43.0		27.0 – 45.0		26.2 – 47.5	
Mean ± SD.	32.56 ± 4.89		33.15 ± 5.27		34.93 ± 6.39	
Median	31.6		33.05		35.8	
^{W}P			0.016*		0.017*	
Bone mass (kg)						
Min. – Max.	7.6 – 17.7		7.7 – 17.6		8.9 – 17.4	
Mean ± SD.	11.82 ± 2.15		11.64 ± 2.08		11.45 ± 1.87	
Median	11.5		11.4		11.2	
^{W}P			<0.001*		<0.001*	
Total	40	100.0	40	100.0	29	100.0

P: p value for paired t-test for comparing the basal value with each of the other values.
^{W}P: p value for Wilcoxon Signed Ranks test for comparing the basal value with each of the other values.
*: Statistically significant at $p \leq 0.05$

Table (5): represents distribution of the studied patients according to their laboratory investigations results at three different intervals (at admission, pre transplant and pre discharge).

Three quarters (75%) of patients had abnormal hemoglobin on admission with a mean of (11.34 ± 2.28) while the day pre transplant it was (10.17 ± 1.88) with statistically significant difference between them (P <0.001). Moreover, regarding hematocrit percent, the study revealed that about three quarters (70%) of studied patients had abnormal hematocrit on admission with a mean of (35.06 ± 6.42) while pre transplant it was (30.62 ± 5.27) with statistically significant difference between them, P value (<0.001). The table showed that

more than half (57.5%) of studied patients had normal RBCs count on admission with a mean of (3.98 ± 0.77 x 10^6/mm^3) while pre transplant it was (3.58 ± 0.64), with statistically significant difference between them, P value (0.001) respectively. Furthermore, as regards white blood cells count, the study revealed that more than half (55%) of studied patients had normal WBCs on admission with a mean of (7.08 ± 6.85 x 10^3/mm^3) while pre transplant it was (2.85 ± 5.67) with statistically significant difference between them, P value (<0.001). The table showed that about three quarters (72.5%) of studied patients had normal platelets on admission with a mean of (229.67 ± 266.4 x 10^3/mm^3) while the day pre transplant it was (141.88 ± 198.8) with statistically significant difference between them, P value (<0.001).

The majority (90%) of studied patients had normal serum potassium on admission with a mean of (4.11 ± 0.52) mg/ dl, while pre transplant it was (3.93 ± 0.38) with no statistically significant difference between them. Moreover, **as for serum sodium**, the table revealed that the majority (85%) of studied patients had normal serum sodium on admission with a mean of (138.58 ± 4.26) mEq/l, while pre transplant it was (135.05 ± 3.14) mEq/l with statistically significant difference between them, P value (<0.001). The table showed that the majority (84%) of patients had normal serum magnesium on admission with a mean of (1.75 ± 0.28) while pre transplant was (1.86 ± 0.36) mg/dl with no statistical difference between them. Furthermore, **regarding serum calcium**, the table showed that the majority (90%) of studied patients had normal serum calcium on admission with a mean of (9.18 ± 0.73) mg/dl while pre transplant it was (9.03 ± 0.49) with no statistically significant difference between them. The study illustrated that RBS was normal on admission with a mean of (107.76 ± 29.56) mg/dl while pre transplant it was (138.05 ± 58.29) with statistically significant difference between them, P value (0.011).

The majority (85%) of studied patients had normal albumin level on admission with a mean of (4.05 ± 0.49) g/dl while pre transplant it was (3.46 ± 0.43) with statistically significant difference between them, P value (<0.001). Moreover, in relation to serum total proteins, the table showed that the majority (95%) of studied patients had normal total proteins on admission with a mean of (7.22 ± 0.86) g/dl while pre transplant it was (6.18 ± 0.57) with statistically significant difference between them P value (<0.001). The table represented that the majority (97.5%) of studied patients had abnormal CRP on admission with a mean of (12.25 ± 11.31) while pre transplant it was (27.48 ± 28.56), with no statistically significant difference between them.

The majority (95%) of studied patients had normal serum total bilirubin at admission with mean (1.83 ± 7.82) mg/dl while pre transplant was (2.05 ± 9.40) with no statistical significant difference between. Moreover, concerning serum glutamic oxaloacetic transaminase (SGOT), the table showed that the majority (89.2) of studied patients had normal SGOT at admission with mean (28.92 ± 11.47) u/l while pre transplant it was (33.97 ± 57.37) with no statistically significant difference between them. The table illustrated that the majority (89.2) of studied patients had normal SGPT at admission with mean (42.54 ± 28.08) u/l while pre transplant it was (42.68 ± 56.63) with no statistically significant difference between them. Furthermore, as regards serum creatinine, the table showed that the majority (95%) of studied patients had normal serum creatinine on admission with a mean of (0.64 ± 0.22) mg/dl while pre transplant it was (0.65 ± 0.45) without statistically significant difference between them. The table showed that the majority (90%) of studied patients had

normal serum uric acid on admission with a mean of (4.83 ± 1.42) mg/dl while pre transplant it was (3.49 ± 1.36) with statistically significant difference between them, P (<0.001).

Table (5): Distribution of the studied patients according to their laboratory investigation results on admission and the day pre transplantation

Complete blood count	On admission		The day pre transplant	
	No.	%	No.	%
Hemoglobin (g/dl)				
Normal	10	25.0	4	10.0
Abnormal	30	75.0	36	90.0
Min. – Max.	6.8 – 17.0		7.4 – 15.2	
Mean ± SD.	11.34 ± 2.28		10.17 ± 1.88	
Median	11.35		9.90	
P			<0.001*	
Hematocrit (%)				
Normal	12	30.0	2	5.0
Abnormal	28	70.0	38	95.0
Min. – Max.	21.0 – 48.8		22.1 – 46.4	
Mean ± SD.	35.06 ± 6.42		30.62 ± 5.27	
Median	36.05		29.95	
P			<0.001*	
RBCs (x10^6 / mm^3)				
Normal	23	57.5	8	20.0
Abnormal	17	42.5	32	80.0
Min. – Max.	2.14 – 5.4		2.46 – 5.91	
Mean ± SD.	3.98 ± 0.77		3.58 ± 0.64	
Median	4.02		3.60	
P			0.001*	
WBCs (x 10^3/mm^3)				
Normal	22	55.0	3	7.5
Abnormal	18	45.0	37	92.5
Min. – Max.	0.99 – 38.0		0.08 – 37.0	
Mean ± SD.	7.08 ± 6.85		2.85 ± 5.67	
Median	5.42		1.79	
^{w}P			<0.001*	
Platelets (x 10^3/mm^3)				
Normal	29	72.5	10	25.0
Abnormal	11	27.5	30	75.0
Min. – Max.	6.0 – 1749.0		10.0 – 1304.0	
Mean ± SD.	229.67 ± 266.4		141.88 ± 198.8	
Median	203.0		104.0	
^{w}P			<0.001*	
Total	40	100.0	40	100.0
Serum electrolytes				
Serum potassium (mEq/l)				
Normal	36	90.0	36	90.0

Abnormal	4	10.0	4	10.0
Min. – Max.	3.0 – 5.1		3.2 – 4.9	
Mean ± SD.	4.11 ± 0.52		3.93 ± 0.38	
Median	4.0		3.95	
WP			0.071	
Serum sodium (mEq/l)				
Normal	34	85.0	24	60.0
Abnormal	6	15.0	16	40.0
Min. – Max.	128.0 – 146.0		129.0 – 140.0	
Mean ± SD.	138.58 ± 4.26		135.05 ± 3.14	
Median	138.0		135.0	
P			<0.001*	
Total	40	100.0	40	100.0

P: p value for paired t-test for comparing the basal value with each of the other values.

WP: p value for Wilcoxon Signed Ranks test for comparing the basal value with each of the other values.

*: Statistically significant at $p \leq 0.05$

Table (5): Distribution of the studied patients according to their laboratory investigation results on admission and the day pre transplantation ***cont***

Serum electrolytes	On admission		The day pre transplant	
	No.	%	No.	%
Serum magnesium (mg/dl)				
Normal	31	83.8	28	82.4
Abnormal	6	16.2	6	17.6
Min. – Max.	1.0 – 2.44		1.2 – 2.9	
Mean ± SD.	1.75 ± 0.28		1.86 ± 0.36	
Median	1.8		1.8	
P			0.210	
Total	37	100.0	34	100.0
Serum calcium (mg/dl)				
Normal	36	90.0	39	97.5
Abnormal	4	10.0	1	2.5
Min. – Max.	7.5 – 10.2		7.2 – 9.7	
Mean ± SD.	9.18 ± 0.73		9.03 ± 0.49	
Median	9.45		9.1	
P			0.169	
Total	40	100.0	40	100.0
RBS (mg/dl)				
Normal	37	100.0	32	82.1
Abnormal	0	0.0	7	17.9
Min. – Max.	59.0 – 200.0		58.0 – 288.0	
Mean ± SD.	107.76 ± 29.56		138.05 ± 58.29	
Median	100.0		128.0	

WP			0.011*	
Total	37	100.0	39	100.0
Serum proteins				
Serum albumin (g/dl)				
Normal	34	85.0	21	52.5
Abnormal	6	15.0	19	47.5
Min. – Max.	3.1 – 5.2		2.6 – 4.5	
Mean ± SD.	4.05 ± 0.49		3.46 ± 0.43	
Median	4.0		3.5	
P			<0.001*	
Total	40	100.0	40	100.0
Total proteins (g/dl)				
Normal	28	75.7	21	56.8
Abnormal	9	24.3	16	43.2
Min. – Max.	5.5 – 8.9		4.9 – 7.4	
Mean ± SD.	7.22 ± 0.86		6.18 ± 0.57	
Median	7.3		6.3	
P			<0.001*	
Total	37	100.0	37	100.0
C reactive protein				
Normal	1	2.5	5	12.5
Abnormal	39	97.5	35	87.5
Min. – Max.	3.3- 60		2.9 – 180.0	
Mean ± SD.	12.25 ± 11.31		27.48 ± 28.56	
Median	8.25		24.5	
WP			0.102	
Total	40	100.0	40	100.0

P: p value for paired t-test for comparing the basal value with each of the other values.
WP: p value for Wilcoxon Signed Ranks test for comparing the basal value with each of the other values.
*: Statistically significant at $p \leq 0.05$
RBS: Random blood sugar

Table (5): Distribution of the studied patients according to their laboratory investigation results on admission and the day pre transplantation ***cont***

Biochemical markers	**On admission**		**The day pre transplant**	
	No.	**%**	**No.**	**%**
Total bilirubin (mg/dl)				
Normal	38	95.0	36	90.0
Abnormal	2	5.0	4	10.0
Min. – Max.	0.2 – 50.0		0.2 – 60.0	
Mean ± SD.	1.83 ± 7.82		2.05 ± 9.40	
Median	0.51		0.50	
WP			0.450	

Total	40	100.0	40	100.0
SGOT (u/l)				
Normal	33	89.2	30	88.2
Abnormal	4	10.8	4	11.8
Min. – Max.	14.0 – 72.0		10.0 – 347.0	
Mean ± SD.	28.92 ± 11.47		33.97 ± 57.37	
Median	28.0		20.0	
^{W}P			0.150	
SGPT (u/l)				
Normal	33	89.2	30	88.2
Abnormal	4	10.8	4	11.8
Min. – Max.	15.0 – 141.0		11.0 – 329.0	
Mean ± SD.	42.54 ± 28.08		42.68 ± 56.63	
Median	33.0		31.0	
^{W}P			0.194	
Total	37	100.0	34	100.0
Creatinine (mg/dl)				
Normal	38	95.0	37	92.5
Abnormal	2	5.0	3	7.5
Min. – Max.	0.30 - 1.30		0.30 – 3.20	
Mean ± SD.	0.64 ± 0.22		0.65 ± 0.45	
Median	0.60		0.60	
^{W}P			0.057	
Total	40	100.0	40	100.0
Uric acid (mg/dl)				
Normal	36	90.0	31	77.5
Abnormal	4	10.0	9	22.5
Min. – Max.	1.8 – 8.4		1.6 – 7.9	
Mean ± SD.	4.83 ± 1.42		3.49 ± 1.36	
Median	4.75		3.1	
P			<0.001*	
Total	40	100.0	40	100.0

P: p value for paired t-test for comparing the basal value with each of the other values.

^{W}P: p value for Wilcoxon Signed Ranks test for comparing the basal value with each of the other values.

*: Statistically significant at $p \leq 0.05$

Table (6): showed that about two thirds of patients (65%) looked overweight. Furthermore, around two thirds (62.5%) had abnormal hair on admission, with (84%) of them had lack of natural shine, while (87.5%) had abnormal hair appearance pre transplant, (88.6%) of them had lack of natural shine and more than half (54.3%) had dry hair. The study revealed that more than two thirds of studied patients (67.5%) had normal face appearance on admission, while (95%) had abnormal face pre transplant with (73.3%) of them having pallor and (60.5%) dark skin over cheeks. Moreover, three quarters of patients (75%) had normal eyes on admission, while pre transplant, the majority have pale conjunctiva. The table showed that the majority (92.5%) of patients had normal lips appearance on admission, while (100%) had abnormal lips pre transplant with (85%) of them having dry lips and (80%) had pale lips.

Furthermore, the majority (87.5%) had normal gums on admission, while (85%) had normal gums pre transplant. Moreover, around two-thirds (62.5%) had abnormal teeth on admission with (88%) of them having dental caries, while (52.5%) had abnormal teeth pre transplant with (95.2%) of them having stained teeth. Additionally, the majority (95%) of patients had normal tongue on admission, while (75%) had abnormal tongue pre transplant with (86.7%) of them having smooth pale tongue, and (80%) had atrophic papillae. The table illustrated that the majority of patients (92.5%) had normal skin on admission, while (87.5%) had abnormal skin pre transplant with (80%) of them having pallor and (71.4%) dyspigmentation at different skin areas. Furthermore, the majority (90%) had normal nails on admission**,** while (35%) had abnormal nail color (pallor) pre transplant.

Table (7): showed that the majority (90%) of studied patients had recent weight change with (63.9%) of them having recent increase in weight, while (70%) had no recent history of gastrointestinal manifestations and the majority (97.5) had no history of food allergies. Moreover, the majority of patients (80%) had no history of nutritional supplement and (87.5%) had no history of alcohol or illegal drugs.

Table (8): illustrated that about two thirds (62.5%) of studied patients consumed three meals per day, while (50%) of patients had no daily snacks and (50%) had snacks with around one third (30%) of them consuming sweets snacks, (62.5%) of patients consumed (1- 2) liters fluid/ day and (75%) had food preferences with (76.7) of them preferring meats. Furthermore, more than three quarters (76.5%) of patients had no food dislikes while (92.5%) had no special diet and the majority (95%) had no religious restrictions related to food.

Table (9): illustrated that more than half (57.5%) of patients consumed foods prepared by other persons, not by themselves while (77.5%) of patients used frying as usual cooking method and (75%) used synthetic margarine for frying while (92.5%) consumed their foods indoors.

Table (10): showed that the intake of macronutrients decreased gradually, reached to the least point the day pre transplant with a highly statistical significant differences between the readings of each macronutrient P (< 0.001). Moreover, the major micronutrients (sodium, potassium, calcium and magnesium) decreased gradually, reached to the least point the day pre transplant, with a highly statistical significant differences between the readings of each micronutrients P (< 0.001 and 0.022) respectively

Table (11): displayed that the mean ideal caloric requirement was (2323.49±347.0) while the mean caloric intake was (889.93±361.48) pre transplant, with highly statistically significant difference between them (P<0.001).

Table (12): presents correlation between body mass index (BMI) the day pre transplantation, engraftment period and length of hospital stay. The patient with BMI <18.5 underwent the longest engraftment period with a mean of (17.5±0.71) days for reaching ANC >500, and (27.0±1.41) days for reaching ANC >1000, with statistically significant difference between them (p<0.001). It was observed that the more the BMI, the less the engraftment period except BMI ≥ 40 in which the engraftment period started to increase again. Furthermore, patients with BMI <18.5 had the longest mean length of hospital stay (42.0±0.0) days.

Table (13): presents correlation between body fat percent pre transplantation and engraftment period. The table displayed no statistical difference between them to reach absolute neutrophil count > 500 while a statistical significant difference between them, (p=0.022) to reach absolute neutrophil count > 1000**,** in which engraftment of patients with recommended amount of fat longer than patient with over fat and obese.

Table (14): presents correlation between body mass index (BMI) pre discharge, engraftment period and length of hospital stay. The patients with BMI (< 18.5) predischarge underwent the longest engraftment period, the mean days to reach absolute neutrophil count (ANC) >500 were (17.0±0.82) and (23.75±4.03) to reach ANC >1000, with statistically significant differences between them (P=0.004 and <0.001) respectively. Furthermore, it was observed that engraftment period decreased with increasing BMI except for BMI (≥ 40), it started to increase again. Moreover, the patients with BMI (< 18.5) had the longest mean length of hospital stay (41.75±1.26), with statistically significant differences between them ((p<0.001).

Table (15): presents correlation between body fat percent pre discharge, engraftment period and length of hospital stay. The patients who have minimal body fat percent post transplantation, were exposed to the longest period of engraftment with a mean of (16.0±2.71) to reach absolute neutrophil count (ANC) more than 500 and (22.25±6.65) to reach ANC more than 1000, with statistically significant difference between them (P=0.005). There was a negative relationship between body fat percent and period of engraftment. Moreover, there was a negative relationship between body fat percent post transplantation and length of hospital stay with statistically significant difference between them (p=0.025).

Table (6): Distribution of the studied patients according to their physical signs of malnutrition on admission and the day pre transplantation

Physical signs		On admission (n=40)		The day pre transplant (n=40)	
		No.	%	No.	%
General appearance	**Weight**				
	Ideal weight	13	32.5	13	32.5
	Overweight	26	65.0	26	65.0
	Underweight	1	2.5	1	2.5
Hair	Normal	15	37.5	5	12.5
	Abnormal*	**25**	**62.5**	**35**	**87.5**
	▪ Lack of natural shine	21	84.0	31	88.6
	▪ Dry	8	32.0	19	54.3
	▪ Thin and sparse	4	16.0	4	11.4
	▪ Wire like	1	4.0	1	2.9
	▪ Color changes (flag sign)	1	4.0	1	2.9
	▪ Easily plucked	1	4.0	1	2.9
	▪ Excessive hair loss	7	28.0	5	14.3
Face	Normal	27	67.5	2	5.0
	Abnormal*	**13**	**32.5**	**38**	**95.0**
	▪ Dark skin over cheeks	0	0.0	23	60.5
	▪ Dark skin under eyes	2	15.4	10	26.3
	▪ Swollen face	0	0.0	1	2.6

	▪ Scaling of skin	0	0.0	1	2.6
	▪ Pale	12	92.3	28	73.7
Eyes	Normal	30	75.0	5	12.5
	Abnormal*	**10**	**25.0**	**35**	**87.5**
	▪ Pale conjunctivae	10	100.0	33	94.3
	▪ Circumcorneal injection	0	0.0	9	25.7
Lips	Normal	37	92.5	0	0
	Abnormal*	**3**	**7.5**	**40**	**100.0**
	▪ Swollen	1	33.3	2	5.0
	▪ Dryness	1	33.3	34	85.0
	▪ Scalling	0	0.0	19	47.5
	▪ Pale	1	33.3	32	80.0
Gums	Normal	35	87.5	34	85.0
	Abnormal*	**5**	**12.5**	**6**	**15.0**
	▪ Swollen	2	40.0	3	50.0
	▪ Bleed easily	3	60.0	1	16.7
	▪ Sores	0	0.0	3	50.0
Teeth	Normal	15	37.5	19	47.5
	Abnormal*	**25**	**62.5**	**21**	**52.5**
	▪ Dental caries	22	88.0	0	0.0
	▪ Stained teeth (gray or black spots)	12	48.0	20	95.2
	▪ Erupted abnormally	0	0.0	1	4.8
Tongue	Normal	38	95.0	10	25.0
	Abnormal*	**2**	**5.0**	**30**	**75.0**
	▪ Swelling	1	50.0	1	3.3
	▪ Atrophic papillae	0	0.0	24	80.0
	▪ Sores	1	50.0	3	10.0
	▪ Smooth pale tongue	1	50.0	26	86.7
Skin	Normal	37	92.5	5	12.5
	Abnormal*	**3**	**7.5**	**35**	**87.5**
	▪ Dryness (xerosis)	0	0.0	9	25.7
	▪ Poor skin turgor	0	0.0	1	2.9
	▪ Dyspigmentation	0	0.0	25	71.4
	▪ Petechiae	0	0.0	1	2.9
	▪ Pallor	3	100.0	28	80.0
Nails	Normal	36	90.0	26	65.0
	Abnormal	**4**	**10.0**	**14**	**35.0**
	▪ Pale	4	100.0	14	100.0
Others	No	35	87.5	38	95.0
	Yes	**5**	**12.5**	**2**	**5.0**
	▪ Peripheral neuropathy	1	2.5	2	5.0
	▪ Muscle cramps after minimal exercise	4	10.0	0	0.0

***** Some cases reported more than one item, Physical sign that had (0) value on admission and pre transplant, removed from table

Table (7): Distribution of the studied patients according to their dietary history

Dietary history		Studied cases (n=40)	
		No.	%
Usual weight (kg)	Min. – Max.	48 – 135	
	Mean ± SD.	80.28 ± 22.19	
	Median	73.0	
Recent weight change	No	4	10.0
	Yes*	**36**	**90.0**
	Recent decrease	13	36.1
	Recent increase	23	63.9
Recent history of GIT manifestations	No	28	70.0
	Yes*	**12**	**30.0**
	Nausea	1	8.3
	Vomiting	3	25.0
	Diarrhea	2	16.7
	Constipation	2	16.7
	Occult blood in stool	2	16.7
	Anorexia	3	25.0
	Heart burn	2	16.7
Duration of GIT manifestations (weeks)	Min. – Max.	1 – 12	
	Mean ± SD.	4.18 ± 3.60	
	Median	4.0	
History of food allergies/ intolerances	No	39	97.5
	Yes	1	2.5
History of nutritional supplement	No	32	80.0
	Yes*	**8**	**20.0**
	Vitamins	6	75.0
	Minerals	3	37.5
	Food supplement	1	12.5
Duration of use of nutritional supplement (weeks)	Min. – Max.	2 – 20	
	Mean ± SD.	10.0 ± 7.01	
	Median	8.0	
History of alcohol or illegal drug use	No	35	87.5
	Yes	5	12.5

***** Some cases reported more than one item

Table (8): Distribution of the studied patients according to their eating pattern pre admission

Eating pattern		Studied cases (n=40) No.	%
Number of meals/ day	Two meals	12	30.0
	Three meals	25	62.5
	> three meals	3	7.5
Number of snacks/ day	No snacks	20	50.0
	One snack	**14**	**35.0**
	> one snack	**6**	**15.0**
Type of snacks*	Vegetables	3	15.0
	Fruits	5	25.0
	Chips	5	25.0
	Sweets	6	30.0
	Others	4	20.0
Usual amount of fluid intake	< one liter	12	30.0
	1-2 liters	25	62.5
	> two liters	3	7.5
Food preferences	No	10	25.0
	Yes*	**30**	**75.0**
	Red meat	11	36.7
	White meat	12	40.0
	Vegetables	5	16.7
	Rice/ pasta	8	26.7
	Salted food	1	3.3
	Dairy	1	3.3
Food dislikes	No	27	67.5
	Yes*	**13**	**32.5**
	Red meat	2	15.4
	White meat	1	7.7
	Vegetables	1	7.7
	Rice/ pasta	1	7.7
	Salted food	1	7.7
	Sweets	3	23.1
	Dairy	2	15.4
	Legumes	4	30.8
Special diet	No	37	92.5
	Yes	**3**	**7.5**
	Diabetic diet	2	66.7
	Vegetarian diet	1	33.3
Religious restrictions related to food	No	38	95.0
	Yes	2	5.0

***** Some cases reported more than one item

Table (9): Distribution of the studied patients according to their self-care behaviours related to food pre admission.

Self- care behaviours related to food		Studied cases (n=40)	
		No.	%
Who prepares meals?	Husband/ wife	14	35.0
	Parents	9	22.5
	Patient him/ herself	17	42.5
Usual method of cooking*	Boiled	10	25.0
	Roasting	8	20.0
	Frying	31	77.5
	Mixed methods	14	35.0
Type of fat used in frying*	Butter	3	7.5
	Vegetable oils	15	37.5
	Natural margarine	6	15.0
	Synthetic margarine	30	75.0
Usual places of eating	Inside home	37	92.5
	Outside home	3	7.5

Table (10): Macro and major micro nutrients of study sample on three different intervals (at admission, midway between admission and transplant and the day pre transplant)

Time		Water (gram)	Cal Energy (K cal)	Total protein (gram)	Animal protein (gram)	Plant protein (gram)	Total fat (gram)	Animal fat (gram)	Plant fat (gram)	Carbohydrates (k cal)	Na Sodium (mg)	K Potassium (mg)	Ca Calcium (mg)	Mg Magnesium (mg)
On admission	**Mean**	1733.7	1230.6	60.2	41.2	19.0	36.7	30.0	6.7	164.8	988.9	807.8	434.3	83.8
	St Dev	502.3	416.3	22.7	18.6	8.7	14.5	12.5	3.2	64.8	386.0	409.4	197.9	33.8
Between admission & transplant	**Mean**	1324.4	896.0	45.2	34.1	11.1	28.7	25.0	3.8	114.1	516.3	528.7	311.3	71.6
	St Dev	501.9	435.3	26.3	21.8	7.6	16.5	15.6	2.8	57.9	310.9	343.2	217.2	36.5
One day pre transplant	**Mean**	958.2	543.1	22.3	15.4	6.9	15.9	13.5	2.4	77.5	289.1	292.3	300.1	45.0
	St Dev	596.0	494.7	22.8	17.2	8.3	16.7	15.2	2.9	72.0	315.6	368.4	333.4	44.7
A N O V A	**F**	**41.269**	**43.863**	**36.445**	**24.478**	**48.633**	**23.183**	**17.806**	**13.449**	**41.524**	**68.071**	**31.153**	**4.022**	**13.887**
	P	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**0.022***	**<0.001***

F, p: calculated and P-value of ANOVA test
*: Statistically significant at $p \leq 0.05$

ISSN: 2208-2670

Table (11): Correlation between ideal caloric requirement and mean caloric intake pre transplantation

Total Caloric Requirement	Pre transplantation (n=40)	
	Ideal caloric requirement	Mean caloric intake
Min. – Max.	1795.26 – 3033.38	206.45 – 1714.87
Mean ± SD.	2323.49±347.0	889.93±361.48
Median	2228.59	860.15
Test of sig. (p-value)	t=-19.705* (p<0.001*)	

t: calculated value of paired t-test
*: statistically significant at p≤0.05

Table (12): Correlation between body mass index (BMI) the day pre transplantation, engraftment period and length of hospital stay

BMI	Days to reach absolute neutrophil count >500			Days to reach absolute neutrophil count >1000			Length of hospital stay		
	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median
▪ < 18.5	17.5±0.71	17-18	17.5	27.0±1.41	26-28	27.0	42.0±0.0	42-42	42.0
▪ 18.5-24.99	14.29±6.57	11-17	15.0	16.71±3.49	13-22	17.0	34.29±5.91	28-43	35.0
▪ 25-29.99	13.6±2.56	10-19	14.0	15.47±3.02	10-19	16.0	36.47±3.68	30-44	35.0
▪ 30-34.99	12.3±2.06	10-16	12.5	14.0±2.75	10-18	15.0	30.6±6.08	21-39	32.0
▪ 35-39.99	11.5±2.12	10-13	11.5	13.5±3.54	11-16	13.5	34.5±0.71	34-35	34.5
▪ ≥ 40	12.5±1.73	11-15	12.0	14.5±2.65	12-18	14.0	35.0±7.17	28-45	33.5
Test of sig. (p-value)	F=2.311 (p=0.065)			F=6.869* (p<0.001)*			F=2.479 (p=0.051)		

F, p: calculated and P-value of ANOVA test
*: Statistically significant at $p \leq 0.05$

Table (13): Correlation between body fat percent the day pre transplantation and engraftment period

Body fat percent	Days to reach ANC >500			Days to reach ANC >1000		
	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median
Minimal	--------	--------	-------	--------	--------	-------
Recommended	14.36±2.62	11-18	15.0	18.09±5.3	12-28	17.0
Over fat	12.6±1.67	10-14	13.0	14.6±3.36	10-19	15.0
Obese	12.08±2.75	10-19	11.0	13.46±3.09	10-19	12.0
Test of sig. (p-value)	F=2.825 (p=0.072)			F=4.215* (p=0.022)*		

F, p: calculated and P-value of ANOVA test
*: Statistically significant at $p \leq 0.05$

Table (14): Correlation between body mass index (BMI) pre discharge, engraftment period and length of hospital stay

BMI	Days to reach ANC >500			Days to reach ANC >1000			Length of hospital stay		
	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median	Mean± SD	Min-Max	Median
▪ < 18.5	17.0±0.82	16-18	17.0	23.75±4.03	19-28	24.0	41.75±1.26	40-43	42.0
▪ 18.5-24.99	13.17±1.94	11-16	12.5	15.0±2.28	13-18	14.5	32.67±3.01	28-35	34.0
▪ 25-29.99	12.89±2.89	10-19	13.0	14.67±3.35	10-19	15.0	34.78±3.11	30-40	34.0
▪ 30-34.99	11.0±1.53	10-14	10.0	12.43±2.51	10-16	11.0	28.29±5.19	21-34	28.0
▪ 35-39.99	------	------	------	------	------	------	------	------	------
▪ ≥ 40	12.67±2.08	11-15	12.0	14.33±3.21	12-18	13.0	31.67±3.22	28-34	33.0
Test of sig. (p-value)	F=5.032* (p=0.004)*			F=9.409* (p<0.001)*			F=9.517* (p<0.001)*		

F, p: calculated and P-value of ANOVA test
*: Statistically significant at $p \leq 0.05$

Table (15): Correlation between body fat percent pre discharge, engraftment period and length of hospital stay

Body fat percent	Days to reach ANC >500			Days to reach ANC >1000			Length of hospital stay		
	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median
▪ Minimal	16.0±2.71	12-18	17.0	22.25±6.65	13-28	24.0	40.25±4.19	34-43	42.0
▪ Recommended	13.2±1.93	11-16	12.5	15.1±2.38	12-19	15.0	33.5±3.95	28-40	34.0
▪ Over fat	12.5±2.92	10-19	12.0	14.0±3.59	10-19	14.0	32.0±5.21	24-40	33.0
▪ Obese	11.4±2.19	10-15	10.0	13.4±3.36	11-18	11.0	30.6±5.41	21-34	33.0
Test of sig. (p-value)	F=2.846 (p=0.058)			F=5.514* (p=0.005)*			F=3.706* (p=0.025)*		

F, p: calculated and P-value of ANOVA test
*: Statistically significant at $p \leq 0.05$

IV. DISCUSSION

The hematopoietic stem cell transplantation population has expanded, to the point that the older patients, with comorbid conditions, may receive transplants. Despite significant advances in treatments over the past 40 years, hematopoietic cell transplantation is associated with considerable treatment related morbidity, prolonged hospitalizations, and long term health problems [(59)]. Ongoing research has demonstrated that diet can significantly influence the development of hematologic malignancies, and in those who are diagnosed, nutritional status has been correlated with overall survival, chemotherapy response rates, toxicity, quality of life, length of stay, functional status, and cost of care outcomes. The present study was carried out to determine the relationship between nutritional status and engraftment time during bone marrow transplantation.

Concerning anthropometric assessment, the three quarters of patients were either overweight or obese pre transplantation according to body mass index and body fat percent measurements. These findings agree with Barritta de Defranchi et al (2014) [(60)], they assessed nutritional status of hematopoietic cell transplantation patients on hospital admission and stated that most of the patients admitted for bone marrow transplant were either overweight or obese according to body mass index, and no underweight patients in their sample. Moreover, Hoffman et al (2013) [(16)] mentioned that over nutrition has been identified as a risk factor in the development of hematologic malignancies. The relationship between increased body mass index and risk for developing both acute and chronic myeloid and lymphoid leukemia has been supported in several large cohort studies as well as Meta analyses.

Moreover**,** the study illustrated a decreased body mass index and body fat percent with statistically difference between body mass index measurements and body fat percent measurements, the day pre transplant and pre discharge. These findings agree with Ferreira (2014) [(61)] who stated that patients submitted to allogeneic hematopoietic stem cell transplantation have compromised nutritional status during the hospital stay for transplantation. The patients showed a worsening in their nutritional status during hospitalization according to anthropometric measurements.

Furthermore, Schutz et al (2002) [(62)] mentioned that the major shortcoming of the body mass index is that the actual composition of body weight is not taken into account: excess body weight may be made up of adipose tissue or conversely muscle hypertrophy, both of which will be judged as excess mass. On the other hand, a deficit of body mass index may be due to a fat free mass deficit (sarcopenia) or a mobilization of adipose tissue or both combined. This attributed to using of body composition measurements to identify actual composition of body weight rather than body mass index alone.

Furthermore, the present study disclosed a negative relationship between each of body mass index and body fat percent pre transplant and time of engraftment to reach absolute neutrophil count >500 without statistical significant difference between them, in which the mean days for engraftment of underweight patient was three days later than normal, four days later than overweight and five days later than obese patient. Also, there is a negative statistical difference between each of body mass index and body fat percent pre transplant and time of engraftment to reach absolute neutrophil count >1000. This attributed to that the higher the body mass index and the higher the body fat percent, the less time of engraftment occurred.

The previous finding is congruent with Hadjibabaie et al (2008) [(15)] who found a negative relationship between patient's body mass index and time of engraftment. In their study, engraftment of underweight patients was three days later than in normal patients and four days later than overweight or obese patients, respectively. Moreover, Hadjibabaie et al

(2012) [63] concluded in their study on leukemic patients undergoing allogenic hematopoietic stem cell transplantation that even though obese patients had a poorer outcome regarding overall survival rate than non-obese patients which was not statistically significant, they showed a significant shorter time to engraftment as a better outcome. This could be related to that obese patients have a better nutritional status pre transplantation than underweight patients that assist them for early engraftment.

Also, there was a borderline negative correlation between body mass index pre transplant and length of stay in which the mean stay of underweight patient was eight days more than normal and six days more than overweight patients. This means that underweight patients had longer engraftment period and longer hospital stay than others, so nutritional intervention is very necessary for these patients. Furthermore, it is expected that the patients who had low and normal body mass index pre transplant that congruent with their body fat percent will exposed more to weight loss and malnutrition post transplantation due to acute phase of early post transplant period, the patient will expose to high severity of side effects of conditioning regimen, fever, catabolic stress, severely decreased oral intake, might exposed to infection due to severe neutropenia and acute graft versus host disease especially in allogeneic high dose regimens. So, monitoring alteration of pre transplant nutritional status is very crucial.

Additionally, the study showed that patients exposed to below normal body mass index and minimal body fat percent were less than one quarter of the studied patients, which is near to the findings with Hadjibabaie et al (2008) [15] who evaluate the nutritional status of patients undergoing hematopoietic cell transplant at Tehran and Iran. They found that 14% of patients undergoing hematopoietic stem cell transplant were underweight. They recommended that patients undergoing hematopoietic stem cell transplant should be provided with nutritional support and their nutritional status be closely monitored to ensure early identification of malnutrition.

Regarding biochemical markers assessment, the current study showed a highly statistical difference between complete blood count readings at admission and pre transplant. In the same line, Hoffman et al (2013) [16] stated that hematologic indices such as hemoglobin, hematocrit, total lymphocyte count, are readily affected by hematologic disorders and prior therapy, therefore they aren't valid parameters for assessment of nutritional status in this population.

Furthermore, the current study illustrated a gradual decrease in serum proteins except C reactive protein with highly significant differences between serum proteins measurements (serum albumin and serum total proteins) at admission and pre transplant and no significant differences between C reactive protein measurements despite its increased level along pre transplantation period. Rzepecki et al (2007) [64] mentioned that plasma concentrations of so-called anabolic proteins such as albumin, transferrin, retinol-binding protein, and prealbumin are frequently used to estimate nutritional status and to monitor the efficacy of nutritional support, but inflammatory response leads to depression of all protein synthesis and rising of inflammatory markers as C reactive protein. Thus, plasma proteins can lose their function as parameters detecting malnutrition. This attributed to; there is no dependency on plasma proteins for nutritional assessment during transplantation except on admission. Other causes of protein depletion are caloric and protein intake deficiencies as measured by food analyses sheets during pre-transplant period.

Additionally, the current study showed disturbances in serum electrolytes along pre-transplantation period. This is in line with Philibert et al (2008) [65], they mentioned that the underlying mechanisms explaining low electrolytes level at bone marrow transplant seem to

be multifactorial and can be grouped into five categories: (i) Reduction of intake, (ii) Gastrointestinal loss, (iii) Intracellular incorporation of electrolytes into the new forming hematopoietic cells, (iv) Enhanced renal loss and (v) Abnormal mineral bone metabolism. Hence, it was justified that serum electrolytes weren't indicator for nutritional status during transplantation period due to their multifactorial disturbances affecting them, but the study can't ignore that gradually decreased oral intake and increased gastrointestinal symptoms were factors that disturbed serum electrolytes.

The current study showed a gradual declining of protein intake with a highly significant difference between protein intake analyses from admission until pre transplantation. This is not in line with Macris et al (2016) [24], they stated that protein intake should be 1- 1.5 g/kg/day during transplant. Hematopoietic cell transplantation recipients have been found to have increased protein requirements and negative nitrogen balance despite the provision of nutritional support. This attributed to diet planning, giving calories based on requirements and manipulation in the shape, flavor and manner of presented food are very important for those patients.

Moreover, the present study illustrated a gradual decline of carbohydrate intake with a highly significant difference between carbohydrate intake analyses from admission until pre transplantation. Mean carbohydrate intake reached the day pre transplant to about 3.5 % from the mean ideal caloric intake pre transplant. This is in contrast to Macris et al (2016) [24], they stated that carbohydrate intake should be 50- 60% of total caloric intake during transplant period and dextrose load for adults <5 mg/kg/min.

Furthermore, the study elaborated a gradual decline of fat intake with a highly significant difference between fat intake analyses from admission until pre transplantation. Mean fat intake the day pre transplant constituted about 6% from mean ideal caloric intake pre transplant. This is in contrast with Macris et al (2016) [24] who stated that fat intake for transplanted patients should be 8% minimum dose and 40% maximum dose of total calories, the minimum dose given only for patients who receive low glucose based parenteral nutrition concentrations. Respectively, no patient in the study sample received parenteral nutrition pre transplantation.

Additionally, food analysis in the present study was congruent with So et al (2012) [66] who concluded that the nutritional intake was gradually decreased from the day pre transplant and reached the lowest value for one week post- transplant and did not recover by two weeks post- transplant. Appropriate nutritional support was not provided despite the low recovery rate of oral intake. This attributed to importance of providing intensive education pre transplantation for increasing food intake during Post-1week and discharge, to increase the overall transplant success rate, decreasing engraftment period and length of hospitalization.

V. CONCLUSION & RECOMMENDATIONS

It is necessary to initiate nutritional assessment and follow up for those patients to prevent malnutrition and to protect the borderline patients to become negatively malnourished and affecting healing time negatively. Moreover, despite the obesity is a risk factor for graft versus host disease and transplantation complications, it is not dangerous as malnutrition in occurrence of late engraftment

REFERENCES

1. Mahla RS. Stem Cells Applications in Regenerative Medicine and Disease Therapeutics. Int J Cell Biol 2016; 2016:6940283
2. Prohaska S, Weissman R. Biology of Hematopoietic Stem and Progenitor Cells. In: Appelbaum FR, Forman SJ, Negrin RS, Blume KJ (eds). Thomas' Hematopoietic Cell Transplantation: Stem Cell Transplantation. USA: Wiley; 2009. 36-63.
3. Prochazkova M, Chavez MG, Prochazka J, Felfy H, Mushegyan V, Klein OD. Embryonic Versus Adult Stem Cells. In: Vishwakarma A, Sharpe P, Ramalingam M. Stem Cell Biology and Tissue Engineering in Dental Sciences. San Francisco: Science Direct; 2015. 249–62.
4. Lad DP, Malhotra P, Varma S. Hematopoietic Stem Cell Applications: Past, Present and Future. J Postgrad Med Educ Res 2012; 46(2):69-74.
5. European Society for Blood and Marrow Transplantation (EBMT). A Guide to the completion of the EBMT. 2016. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwj9wuThrrfbAhUFr6QKHZD0Cm0QFggmMAA&url=http%3A%2F%2Fwww.ebmt.org%2Fsites%2Fdefault%2Ffiles%2F2018-03%2FMED-AB%2520Forms%2520Manual.pdf&usg=AOvVaw3I7DWg1KkdxYiWIE6cxvJy Retrieved on: Feb, 2018
6. Aerts E, Babic A, Devine H, Kerache F, Mank A, Schouten H. Haematopoietic Stem Cell Mobilization and Apheresis: A Practical Guide for Nurses and Other Allied Health Care Professionals. European Group for Blood and Marrow Transplantation- Nurses Group (EBMT NC); 2009 .
7. Mahmoud HK, EL-Haddad AM, Fahmy OA, El-Emary M, Nassar A, Abdel-Mooti M. Hematopoietic stem cell transplantation in Egypt. Bone Marrow Transplantat 2008; 42: 576-80
8. Statistical records of Bone Marrow Transplant Unit, Nasser Institute Hospital at Cairo affiliated to Ministry of Health.
9. Sureda A, Bader P, Cesaro S, Dreger P, Duarte RF, Dufour C. Indications for allo- and auto-SCT for haematological diseases, solid tumours and immune disorders: current practice in Europe, 2015. Bone Marrow Transplantat 2015; 50:1037-56.
10. Muscaritoli M, Grieco G, Capria S, Iori AP, Fanelli FR. Nutritional and metabolic support in patients undergoing bone marrow transplantation. The American Journal of Clinical Nutrition 2002; 75(2): 183- 190
11. Horsley P, Bauer J, Gallagher B. Poor nutritional status prior to peripheral blood stem cell transplantation is associated with increased length of hospital stay. Bone Marrow Transplantat 2005; 35: 1113–116.
12. Akbulut G. Medical nutritional therapy in hematopoietic stem cell transplantation (HSCT). Int J Hematol Oncol 2013; 23(1):55-65
13. Bassim CW, Fassil H, Dobbin M, Steinberg SM, Baird K, Cole K. Malnutrition in patients with chronic GVHD. Bone Marrow Transplantation 2014; 49: 1300–306
14. Weiss BM, Vogl DT, Berger NA, Stadtmauer EA, Lazarus HM. Trimming the fat: obesity and hematopoietic cell transplantation. Bone Marrow Transplantat 2013; 48:1152-60
15. Hadjibabaie M, Iravani M, Taghizadeh M, Ataie-Jafari A, Shamshiri AR, Mousavi SA. Evaluation of nutritional status in patients undergoing hematopoietic SCT. Bone Marrow Transplantat 2008; 42(7): 469-73.
16. Hoffman R, Benz EJ, Silberstein LE, Heslop HE, Weitz JI, Anastasi J. Hematology Basic Principles and Practice. 6th ed. Canada: Elsevier Saunders; 2013

17. Sauer A, Alish C, Strausbaugh K, West K, Quatrara B. Nurses needed: identifying malnutrition in hospitalized older adults. Elsevier 2016; 2: 21-5
18. Jefferies D, Johnson M, Ravens J. Nurturing and nourishing: the nurses' role in nutritional care. J Clin Nurs 2011; 20(3-4):317-30.
19. Yarbro CH, Wujcik D, Gobel BH. Cancer Nursing: Principles and Practice. 7th ed. Canada: Jones and Bartlett; 2011
20. Lavdaniti M. A nursing perspective of nutrition in cancer patients undergoing chemotherapy. Prog Health Sci 2014; 4(2):131-34
21. Tomblyn M, Chiller T, Einsele H, Gress R, Sepkowitz K, Storek J. Guidelines for preventing infectious complications among hematopoietic cell transplantation recipients: a global perspective. Biol Blood Marrow Transplant 2009; 15:1143-238
22. Food Safety. Gov. Food Safety for Cancer Patients. 2018. Available at: https://www.foodsafety.gov/risk/cancer/index.html. Retrieved on: Feb, 2018.
23. Habschmidt MG, Bacon CA, Gregoire MB, Rasmussen HE. Medical nutrition therapy provided to adult hematopoietic stem cell transplantation patients. Nutr Clin Pract 2012; 27(5):655-60.
24. Macris PC, McMillen KK. Nutrition Support of the Hematopoietic Cell Transplant Recipient. In: Forman S, Negrin R, Antin J, Appelbaum F (eds). Thomas' Hematopoietic Cell Transplantation. 5th ed. Singapore: John Wiley & Sons, Ltd; 2016
25. Ezzone S, Pokorny K. Blood and Marrow Stem Cell Transplantation: Principles, Practice and Nursing Insights. 3rd ed. United States of America. Jones &Bartlett; 2007
26. Lee SY, Gallagher D. Assessment methods in human body composition. Curr Opin Clin Nutr Metab Care 2008; 11(5):566-72.
27. Rondel A, Langius J, De van M, Kruizenga H. The new ESPEN diagnostic criteria for malnutrition predict overall survival in hospitalised patients. Clin Nutr 2018; 37(1):163-68.
28. Maziarz RT, Slater SS. Blood and Marrow Transplant Handbook: Comprehensive Guide for Patient Care. 2nd ed. New York: Springer; 2015
29. Marian M, Roberts S. Clinical Nutrition for Oncology Patients. United States of America: Jones and Bartlett; 2010.
30. Kondrup J, Allison S, Elia M, Vellas B, Plauth M. ESPEN Guidelines for Nutrition Screening 2002. Clin Nutr 2003; 22(4):415-21.
31. Kumar NB. Nutritional Management of Cancer Treatment Effects. Verlag Berlin Heidelberg: Springer; 2012.
32. Schutz Y, Kyle UUG , Pichard C. Fat-free mass index and fat mass index percentiles in Caucasians aged 18–98 y. Int J Obes Relat Metab Disord 2002; 26(7):953-60.
33. Sardesai VM. Introduction to Clinical Nutrition. 2nd ed. New York: Marcel Dekker; 2003.
34. Lee SY, Gallagher D. Assessment methods in human body composition. Curr Opin Clin Nutr Metab Care 2008; 11(5):566-72.
35. Kyle UG, Bosaeus I, De Lorenzo AD, Deurenberg P, Elia M, Manuel Gómez J, et al. Bioelectrical impedance analysis-part II: utilization in clinical practice. Clin Nutr 2004; 23:1430-53.
36. Latifi R, Merrell RC. Nutritional Support in Cancer and Transplant Patients. Georgetown, Texas, U.S.A: Landes Bioscience; 2001.
37. Jain S, Gautam V, Naseem S. Acute-phase proteins: As diagnostic tool. J Pharm Bioallied Sci 2011; 3(1): 118–27.

38. El-Deeb DK. Nutritional Assessment of Children with Cancer Attending the Pediatric Oncology Unit, Alexandria Main University Hospital, Egypt. Doctorate Dissertation. Faculty of Medicine: Alexandria University; 2016.
39. Unal D, Orhan O, Eroglu C, Kaplan B. Prealbumin is a more sensitive marker than albumin to assess the nutritional status in patients undergoing radiotherapy for head and neck cancer. Contemp Oncol (Pozn) 2013; 17(3):276-80.
40. Blaser BW, Kim HT, Alyea EP, Ho VT, Cutler C, Armand P, et al. Hyperlipidemia and Statin Use after Allogeneic Hematopoietic Stem Cell Transplantation. Biol Blood Marrow Transplant 2012; 18(4):575-83.
41. Baliga KV, Sharma PK, Prakash MS, Mostafi M. Lipid Profile in Transplant Patients: A Clinical Study. MJAFI 2002; 58:32-5.
42. Rolfes SR, Pinna K, Whitney E. Understanding Normal and Clinical Nutrition. 8th ed. Canada: Yolanda Cossio; 2009.
43. Shim JS, Oh K, Kim HC. Dietary assessment methods in epidemiologic studies. Epidemiol Health 2014; 36:e2014009.
44. Institute of Medicine (US) Committee on Dietary Risk Assessment in the WIC Program. Dietary Risk Assessment in the WIC Program. Washington (DC): National Academies Press (US); 2002.
45. Geirsdottir OG, Thorsdottir I. Nutritional status of cancer patients in chemotherapy; dietary intake, nitrogen balance and screening. Food Nutr Res 2008; 52: 10.
46. Lukmanji Z, Hertzmark E, Mlingi N, Assey V, Ndossi G, Fawzi W. Muhimbili University of Health and Allied Sciences (MUHAS), Dar es Salaam – Tanzania and Tanzania Food and Nutrition Centre (TFNC), Dar es Salaam – Tanzania and Harvard School of Public Health (HSPH), Boston, USA: Tanzania Food Composition Tables. 1st ed. Tanzania F: DeskTop Productions Limited; 2008.
47. Volp AC, De Oliveira FC, Alves RD, Esteves EA, Bressan YJ. Energy expenditure: components and evaluation methods. Nutr Hosp J. 2011; 26(3):430-40.
48. Ferrie S, Ward M. Back to basics: estimating energy requirements for adult hospital patients. Nutrition & Dietitics 2007; 64: 192- 99.
49. Yarbro CH, Wujcik D, Gobel BH. Cancer Nursing: principles and practice. 7th ed. Canada: Jones and Bartlett; 2011.
50. Lavdaniti M. A nursing perspective of nutrition in cancer patients undergoing chemotherapy. Prog Health Sci 2014; 4(2):131-34.
51. Maziarz RT, Slater SS. Blood and Marrow Transplant Handbook: Comprehensive Guide for Patient Care. 2nd ed. New York: Springer; 2015.
52. Beurer BF 100 Instructions for Use Manual: About the Device; Explanation of Symbols; Safety Notes. The Ultimate Manuals Library; 2018. Available at: https://www.manualslib.com/manual/1082809/Beurer-Bf-100.html?page=14#manual
53. Dougherty L, Lister S. The Royal Marsden Manual of Clinical Nursing Procedures. 9th ed. Oxford: John Wiley & Sons, Ltd; 2015.
54. Webster-Gandy J, Madden A, Holdsworth M. Oxford Handbook of Nutrition and Dietetics. 2nd ed. United States: Oxford University Press; 2012.
55. Catharine Ross A, Caballero B, Cousins RJ, Tucker KL, Ziegler TR. Modern Nutrition in Health and Disease. 11th ed. China: Lippincott Williams & Wilkins; 2014.
56. High Institute of Public Health, Alexandria University. Food Composition Tables for Egypt; 2006.
57. Kirkpatrick LA, Feeney BC. A simple guide to IBM- SPSS statistics for version 20.0. Studented. Bemont, Calif: Wadsworth, Cengage Learning; 2013.

58. Moriya N, Fegshan Yang, Steven T. Noise- related multi-variate optimal joint- analysis in longitudinal stochastic processes. Nova Sci Publishers 2008; 38(3):223-60.
59. Fabbro E, Baracos V, Wahnefried W, Bowling T, Hopkinson J, Bruera E. Nutrition and Cancer Patient. United States: Oxford University Press; 2010.
60. Barritta de Defranchi RL, Bordalejo A, Cañueto I, Villar A, Navarro E. Evolution of nutritional status in patients with autologous and allogeneic hematopoietic stem cell transplant. Support Care Cancer 2015; 23(5):1341-7.
61. Ferreira EE, Guerra DC, Baluz K, de Resende Furtado W, da Silva Bouzas LF. Nutritional status of patients submitted to transplantation of allogeneic hematopoietic stem cells: a retrospective study. Rev Bras Hematol Hemoter 2014; 36(6):414-9.
62. Schutz Y, Kyle UUG , Pichard C. Fat-free mass index and fat mass index percentiles in Caucasians aged 18–98 y. Int J Obes Relat Metab Disord 2002; 26(7):953-60.
63. Hadjibabaie M, Tabeefar H, Alimoghaddam K, Iravani M, Eslami K, Honarmand H. The relationship between body mass index and outcomes in leukemic patients undergoing allogeneic hematopoietic stem cell transplantation. Clin Transplant J 2012; 26: 149–155.
64. Rzepecki P, Barzal J, Sarosiek T, Szczylik C. Biochemical indices for the assessment of nutritional status during hematopoietic stem cell transplantation: are they worth using? A single center experience. Bone Marrow Transplantat 2007; 40:567-72.
65. Philibert D, Desmeules S, Filion A, Poirier M, Agharazii M. Incidence and severity of early electrolyte abnormalities following autologous haematopoietic stem cell transplantation. Nephrol Dial Transplant 2008; 23:359-63.
66. So EJ, Lee JS, Kim JY. Nutritional intake and nutritional status by the type of hematopoietic stem cell transplantation. Clin Nutr Res 2012; 1(1):3-12.