



response and are at a greater risk of infection. Therefore, they require a neutropenic diet until the recovery of their immune system (4). The neutropenic diet reduces the introduction of food with high levels of bacteria into the body (5, 6). This kind of diet is also called sterile diet, low microbial diet, and low bacterial diet.

The variations of the neutropenic diet include an exclusive sterile diet (e.g., all foods that have been made sterile by canning, baking, autoclaving, and irradiation), low bacterial diet (only well-cooked foods), and modified house diet (i.e., a regular diet omitting fresh fruits and vegetables) (7-10). therefore, most of the oncology centers apply preventive measures to minimize exposure to infectious agents (11).

Despite the necessity of monitoring the neutropenic diet in patients undergoing bone marrow transplantation, limited studies have been performed in Iran to investigate this issue (12). With this background in mind, the present study was conducted to evaluate the neutropenic diet of patients undergoing bone marrow transplantation and investigate the bacterial contamination of hospital food following HSCT.

## Material and methods

Microbiological and nutritional quality analyses were performed for the regular and neutropenic diets offered to patients undergoing bone marrow transplantation that were admitted to Shariati hospital, Tehran, Iran. Considering the similarity of food in the whole hospital and its different sections, to ensure the sterility of food used for the patients subjected to bone marrow transplantation, the food samples were collected in sterilized containers and analyzed in ViroMed laboratory in Tehran, Iran, from January to September 2017.

A total of 12 food samples were obtained from the kitchen (sending to the bone marrow transplantation section) of Shariati Hospital on different days.

The food samples included cooked rice, soup (3 turns), rice and chicken (Iranian traditional name: Reshte Polo) (2 turns), veal, cotyledon, and potato (Iranian traditional name: Qeime), rice with green beans and veal (Iranian traditional name: Lobia Polo), rice and vegetables (Iranian traditional name: Sabzi Polo), as well as meat and chicken (2 turns). Sample derivative in each sampling series was taken from the main dish before its consumption by the patients. The food samples were kept in a cool container in accordance with standard conditions and transported to the food lab in the shortest time interval.

Before performing the necessary tests, the samples were mixed and homogenized, and then subjected to the corresponding tests. In order to study the microbial quality of the foods, they were investigated in terms of total counting of bacteria, coliforms, *Staphylococcus aureus*, yeasts, molds, *Bacillus cereus*, *Salmonella* species, and *Escherichia Coli* using the standard method of the American Public Health Association (APHA) (13). In addition, neutropenic diet was studied in these patients based on the available guidelines (8, 14-16).

## Results

The pathogens examined in this study were subjected to total bacterial count (Table 1). The results were indicative of a complete compliance of neutropenic diet with the FDA standards without any discrepancies. Table 1 presents the information regarding the counting of the microbial properties of the examined foods. Furthermore, the examination and monitoring of the compliance of the food served in the transplant department under investigation with the neutropenic diet criteria in terms of the intake of fresh fruits, fresh vegetables, raw or undercooked meats and fish, and soft cheese made from unpasteurized milk revealed that the regimen was fully consistent with the given criteria (Table 2) (17).

**Table1.** Results of the bacterial counts of hospital food samples the standards of the Ministry of Health and Food and Drug Administration

Cooked Rice					
Row	Feature / Test Description	Test result	Unit	Normal range	
1	Total bacterial count	$5 * 10^2$	CFU/g	Maximum 100,000	
2	Coliform	Less than 10	CFU/g	Maximum 100	
3	<i>Staphylococcus aureus</i>	Negative	CFU/g	Negative	
4	Molds	10	CFU/g	Maximum 100	
5	<i>Bacillus cereus</i>	Less than 10	CFU/g	Less than 10	
6	<i>Escherichia Coli</i>	Negative	CFU/g	Negative	

Soup, Qeime, and meat				
Row	Feature / Test Description	Test result	Unit	Normal range
1	Total bacterial count	Less than 10	CFU/g	Maximum 100,000
2	Coliform	Less than 10	CFU/g	Maximum 100
3	<i>Staphylococcus aureus</i>	Negative	CFU/g	Negative
4	Molds	Less than 10	CFU/g	Maximum 100
5	<i>Salmonella species</i>	Negative	CFU/25g	Negative
6	<i>Escherichia Coli</i>	Negative	CFU/g	Negative
Reshte Polo and Sabzi Polo				
Row	Feature / Test Description	Test result	Unit	Normal range
1	Total bacterial count	Less than 10	CFU/g	Maximum 100,000
2	Coliform	Less than 10	CFU/g	Maximum 100
3	<i>Staphylococcus aureus</i>	Negative	CFU/g	Negative
4	Molds	Less than 10	CFU/g	Maximum 100
5	<i>Bacillus cereus</i>	Less than 10	CFU/g	Less than 10
6	<i>Salmonella species</i>	Negative	CFU/25g	Negative
7	<i>Escherichia Coli</i>	Negative	CFU/g	Negative
chicken				
Row	Feature / Test Description	Test result	Unit	Normal range
1	Total bacterial count	100	CFU/g	Maximum 100,000
2	Coliform	Less than 10	CFU/g	Maximum 100
3	<i>Staphylococcus aureus</i>	Negative	CFU/g	Negative
4	Molds	Less than 10	CFU/g	Maximum 100
5	<i>Salmonella species</i>	Negative	CFU/25g	Negative
6	<i>Escherichia Coli</i>	Negative	CFU/g	Negative
Lobia Polo				
Row	Feature / Test Description	Test result	Unit	Normal range
1	Total bacterial count	100	CFU/g	Maximum 100,000
2	Coliform	Less than 10	CFU/g	Maximum 100
3	<i>Staphylococcus aureus</i>	Negative	CFU/g	Negative
4	Molds	Less than 10	CFU/g	Maximum 100
5	<i>Bacillus cereus</i>	Less than 10	CFU/g	Less than 10
6	<i>Salmonella species</i>	Negative	CFU/25g	Negative
7	<i>Escherichia Coli</i>	Negative	CFU/g	Negative

**Table 2.** Food safety advice during neutropenia

Foods to Avoid	Foods That Can Be Eaten
<ul style="list-style-type: none"> <li>• Raw and undercooked meats, tofu, eggs, and egg substitutes</li> <li>• Unpasteurized dairy products and juices</li> <li>• Soft cheeses and those with molds, chili peppers, or uncooked vegetables</li> <li>• Raw vegetable sprouts</li> <li>• Raw or non-heat-treated honey</li> <li>• Well water (unless tested daily)</li> <li>• Unroasted nuts or roasted nuts in the shell</li> <li>• Raw grain products</li> <li>• Raw egg-containing foods (e.g., cookie dough)</li> <li>• Eating at delicatessens</li> </ul>	<ul style="list-style-type: none"> <li>• Hard or processed cheeses and soft cheeses from pasteurized milk</li> <li>• Fully cooked smoked fish or seafood</li> <li>• Hot dogs reheated until steaming hot</li> <li>• Grilled sandwiches with steaming hot meat or poultry</li> <li>• Fully cooked fish</li> <li>• Fully cooked eggs</li> <li>• Fruits and vegetables that are washed thoroughly (even those with skin that will be peeled or those items claimed to be prewashed)</li> <li>• Cooked vegetable</li> </ul>

## Discussion

Today, there are several examples of the problems caused by the supply of contaminated food to vulnerable patients in the hospital. These problems can be caused both directly by the intake of food contaminated with intestinal pathogens or microbial toxins and indirectly by the transfer of pathogens responsible for

nosocomial infections into the hospital. Cancer patients on chemotherapy are often instructed to follow a neutropenic diet with the goal of reducing the risks of infection and mortality.

This study evaluated the current practices regarding the use of the neutropenic diet among the inpatients undergoing bone marrow

transplantation. As the findings indicated, in Shariati Hospital, the neutropenic diet in patients with bone marrow transplantation that should receive food with the lowest microbial load was in accordance with the FDA guidelines.

Criteria for dietary restrictions vary between hospitals. In this regard, Smith and Besser investigated 400 members of the Association of Community Cancer Centers and reported that 78% of the responding hospitals restricted the diets of the patients with neutropenia (9). In another study, French et al. (2001) examined 10 bone marrow transplant centers in Canada and northwestern United States and reported that five of the seven responding hospitals used a neutropenic diet<sup>18</sup> Furthermore, in another study, 66% of the responding transplant units enforced some types of modified microbial diet (19).

Despite the limited evidence supporting the merits of the neutropenic diet for immunocompromised patients, the restrictive diet continues to be prescribed in the oncology community. In the present study, the neutropenic diet was fully respected in the patients undergoing bone marrow transplantation. In contrary to our findings, Gholammostafaei et al. (2014) reported the outbreaks of food-borne disease in hospitals and the frequency of *Escherichia coli* in the hospital kitchens of Iran as 8% (20). Nevertheless, there is no published study on the microbiological quality of catered food served in the bone marrow transplantation departments in Iran. Therefore, the results of this study could not be compared with any other data.

## Conclusion

Considering the importance of neutropenic diet in patients undergoing bone marrow transplantation, our results revealed that this diet was fully in accordance with the standards of the APHA and FDA in the context under investigation.

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## Conflict of interest

The authors have no conflicts of interest.

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