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# A preliminary study of environmental risks: application of an enteral diet manipulation center

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**Abstract**

The open system enteral diet is a great alternative to nourish patients who cannot eat orally or need a greater caloric/protein intake as an adjuvant in medical treatment. This work aimed to identify and prioritize risks in the processing stages of enteral diets. This research was used as a tool for preliminary risk analysis. Nine risks were identified, six physical and three biological. The risks with the most significant impact were humidity, temperature, and equipment. It was verified that the control and monitoring measures of the sector through a checklist and the Preliminary Risk Analysis were effective in reducing the probability of the occurrence of these risks.

**Keywords:** environmental risk; temperature; humidity; microbiological control.

**Practical Application:** This study provides a preliminary assessment of occupational risks in an enteral diet manipulation center, minimizing the risks of accidents and contamination of enteral diets.

## 1 Introduction

Nutritional therapy (NT) in Brazil consists of feeding through gastric or enteral tubes. Through the enteral diet, the purpose of NT, is essential nutrition for the maintenance of body structures and physical development, in situations where oral feeding is compromised (Vassilyadi et al., 2013).

In European countries, nutritional therapy NT is established as any form of nutritional support that involves the use of diets with specific medical purposes, regardless of the route administered, that is, the administration of commercial products is also considered a diet enteral (Carrera, 2011).

However, nutritional therapy in an open system is characterized by being produced in a restricted, specific, and monitored area, where industrialized nutrients, in powder or liquid form, are mixed, following good handling practices (Silva et al., 2012).

Thus, it becomes possible to modify the diet to meet each patient in a specific way, especially about protein adequacy through the addition of protein modules in the reconstitution of diets, since closed system diets do not meet the protein needs of critically ill patients, often leading to an exacerbation of the individual's caloric need (Santos & Araújo, 2019). Another advantage would be the introduction of fibers to the formulation as a way to prevent intestinal complications (Catalani et al., 2003; Nakao et al., 2002).

Despite the benefits of open system enteral diets, researchers state that the risk of contamination of these formulas occurs during the preparation of diets, due to failures in the disinfection process of equipment, utensils, and surfaces. However, manipulation is considered by researchers to be the most important step. Process for bacterial proliferation, becoming a vector of infection for patients undergoing enteral nutritional therapy if preventive hygiene measures are not carried out according to the manual of good food practices (Blumenstein et al., 2014; Costa et al., 2022; Ferreira et al., 2020).

Furthermore, the manual of good practices is the document that describes the operations carried out by the establishment, including, at a minimum, the hygienic and sanitary requirements of the buildings, the maintenance and hygiene of the installations, equipment and utensils, the control of supply water, integrated control of vectors and urban pests, professional training, hygiene and health control of handlers, waste management and quality control and assurance of prepared food (Brasil, 2004).

Additionally, occupational hazards can be classified as physical, chemical, biological, accidental, and ergonomic, where agents present in work environments that, depending on the time and intensity to which the employee is exposed, are capable of causing problems to the worker's health (Brasil, 2021).

Therefore, risk assessment makes it possible to know the actual situation of the workplace about employee safety and thus create adequate prevention measures (Dimulescu & Dobrotă, 2018).

In this context, an important tool used to help detect and prevent potential risks in the work environment is the preliminary risk analysis (PRA). Based on observational analyzes of environmental conditions and activities performed by employees, it manages to qualify the risks through its

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methodology. In this way, it is possible to identify which parts of the process can operate out of control and unexpectedly, listing the causes, ways of detection, and possible consequences generated for each situation (Jeronimo et al., 2013). This study proposes a preliminary survey of occupational risks in an enteral diet manipulation center.

## 2 Materials and methods

The work was carried out in a food and nutrition unit of an oncology hospital, in Rio de Janeiro-RJ, enteral diet manipulation center (EDMC). The EDMC serves an average of 60 inpatients and outpatients, using enteral nutrition (EN) and nutritional supplements, operating 24 hours a day.

The technical staff, which includes the sector's nutrition team, works on a 12/36 h shift scale, with a total of 10 employees involved in the preparation of the EN, two nutritionists (on duty), two nutrition and dietetics technicians (on duty), 6 handlers 4-day shift workers and 2-night shift workers). The research was developed in the period from January 2021 to January 2022 through the analysis of checklists applied in the EDMC based on federal health legislation, Resolution No. 216/2004, and preliminary risk analysis. In addition, observational analyses and photographic reports were carried out.

Following the daily records made by the checklists, PRA was carried out. The most critical solutions to be prioritized are the prevention, and the correction of the failures found. Weekly microbiological analyzes are also carried out, including ambient air (with fungus and bacteria analyses), water, all equipment used to prepare diets by swab and rodac, microbiological analysis of the employees' hands, and the reprocessed diets.

For the PRA, a spreadsheet was used that first identified the hazards, causes, and damages textually. Next, the probability of occurrence and the severity (impact) are identified. The scale for probability is high (3), medium (2), low (1). For severity: high (3), medium (2), low (1). The risk level is scored by multiplying the assigned values, respectively the probability and severity of the risk (Benite, 2004).

Pearson's correlation coefficient (r) was used to determine the relationship between the variables (Aldrich, 1995). Additionally, to measure the reliability of internal consistency and reflect the degree of correlation between the domain variables, Cronbach's alpha (α) and McDonald's omega (ω) indices were used with a confidence interval of 95% (Silva et al., 2011; Cortina, 1993) using the Jamovi 2.3.0 program.

## 3 Results and discussion

The result of the survey of hazards, situations, damages, and risk assessment are shown in Table 1. In total, nine risks were identified, six of which were physical and three biological according to NR 9 (Brasil, 2020).

The assessment of environmental risks is critical because with the data obtained it is possible to develop mitigating measures to minimize or eliminate the risks, improving the workers' work environment, health, and safety (Pinto et al., 2022).

The risks with a more remarkable power of occurrence and impact are humidity, temperature, and contamination of equipment by microorganisms. Regarding humidity and

**Table 1**. Preliminary risk analysis.

| Preliminary Risk Analysis | | | | | |
|---|---|---|---|---|---|
| Hazards Identification | | | Risk Assessment | | |
| Hazard | Situation | Damage | P | G | Risk (P x G) |
| Humidity outside the standard limits | Levels above those recommended by the ABNT NBR 7256 (50-60%) | Thermal discomfort and risk of proliferation of fungi and bacteria | 2 | 3 | 6 |
| Inappropriate temperature | Levels within the limit recommended by the ABNT NBR 7256 until 24 ºC | Thermal discomfort and risk of proliferation of fungi and bacteria | 2 | 3 | 6 |
| Hands asepsis | As expected | Contamination of diets | 1 | 3 | 3 |
| Contamination of equipment by microorganisms | Blender with small cracks not visible | Contamination of diets | 2 | 3 | 6 |
| Presence of pests and rodents | Not identified | Contamination of diets and damage to worker health | 1 | 2 | 2 |
| Hygiene | According to the regulatory standard | Contamination of diets and damage to worker health | 1 | 2 | 2 |
| Water quality | According to the regulatory standard | Contamination of diets | 1 | 2 | 2 |
| Ambient air | According to the regulatory standard | Contamination of diets and damage to worker health | 1 | 2 | 2 |
| Reprocessed enteral diet | According to regulatory standard | Contamination of diets | 1 | 2 | 2 |

Adapted from Benite (2004). Criteria for analyzing the PRA matrix: [3] = P (high), [2] = P (mean), [1] = P (low); [3] = G (high), [2] = G (mean), [1] = G (low); [Risk] = result of multiplying the P x G factors.

temperature control, it is clear that these are important to inhibit bacterial growth and ensure a comfortable environment for employees. In the handling center, the average values for these parameters varied between 62-72% and 19-20 ºC. Therefore, both are outside the reference values recommended by legislation (Associação Brasileira de Normas Técnicas, 2005). However, to mitigate these risks, temperature and humidity checks are carried out three times a day through a thermohygrometer (Figure 1a) and the refrigeration technician is activated if the parameters are showing excessive variations. In addition, analyses of fungi and bacteria present in the air are carried out weekly through the impactor device (Figure 1b) to ensure air quality. About contamination by mesophiles verified in the blender device, it was replaced by a domestic mixer (Figure 1c) due to the ease of cleaning associated with better environmental comfort and less noise. Additionally, to establish the well-being of workers and the quality of the final product, additional training was also carried out with workers for the proper cleaning of equipment (Brasil, 2004, 2021).

The temperature recommended by ABNT 7256 must be between 21 and 24 ºC and the relative humidity between 40% and 60%. However, the established ambient temperature considered, among other elements, the clothes of the handlers (Figure 1d). This garment does not allow a comfortable ambient temperature established at 21 ºC, consistently below this limit. Similarly to the temperature parameter, the established average relative humidity is above that determined by legislation. However, to guarantee quality, it is constantly monitored. Regular microbiological analyzes confirm that moisture does not pose a risk of contamination of diets. As a result, no discomfort was observed on the part of the workers. In this way, it can be observed that the EDMC maintains the environmental comfort for the team and the quality of the diets guaranteed through fungal and microbiological control of the ambient air.

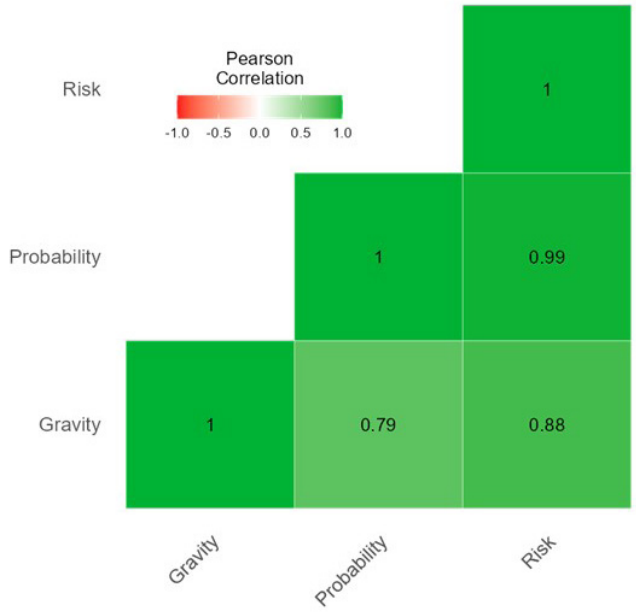


**Figure 1**. Heatmap of Pearson correlation coefficient matrix.

Furthermore, it was found (Table 1) that the other risks analyzed presented a lower degree of risk. Among the mitigating measures used are the training of employees about personal hygiene, the disinfection of the place periodically (Brasil, 2021) by an outsourced company according to RDC nº 52/2009, the analysis of the water quality carried out (Figure 1e) weekly through Ordinance No. 2974 and microbiological analysis of reconstructed diets (Figure 1f) according to RDC 503, which sets the maximum limit of microorganisms present to maintain the integrity of the patient.

In the industrial space, the awareness and engagement of employees in safety prove the link between the execution of work and occupational safety (Hu et al., 2022).

Thus, training and supervision of employees are of extreme importance for the hygienic-sanitary process, identifying the direct relationship between food contamination and the training of handlers (Ferreira et al., 2020).

Thus, staff education on proper food handling practices, personal hygiene, and food safety standards is vital to minimize problems arising from workers at different stages of the process (Xu & Yang, 2022).

Considering the theme addressed, the control of the stages of production of enteral diet has to be rigorous, the indicators of nutritional quality, establish a relationship of surveillance and monitoring in search of excellent results in the nutritional care of the patient (Blanc et al., 2015).

The Heatmap of the Pearson correlation coefficient matrix for probability, severity, and the degree of risk, is presented in Figure 2.

It is possible to analyze that there is a strong correlation between the two analyzed variables and their product. All two-by-two correlations show r above 0.75, which points to a strong positive correlation.

Cronbach's α was 0.70 (gravity), 0.71 (probability) and 0.88 (risk). McDonald's ω was 0.99 (gravity), 0.93 (probability) and 0.88 (risk). Values lower than 0.70 indicate a low correlation between the items and values greater than 0.90 indicate a very strong correlation (Hair et al., 2009).

The results of the photographic report at the enteral diet manipulation center are shown in Figure 1.

The use of the term hygrometer is of fundamental importance in the verification of temperature and humidity (a). The impactor guarantees the safety of the ambient air, confirming the effectiveness of the temperature and humidity with the analysis of fungi and bacteria in the air (b). The swab of the mixer for verification of microorganisms (c). The attire of workers with personal protective equipment suitable for personal protection and safety of the quality of diets (d).

Water potability analysis and verification of the absence of bacteria (e). Swab and rotation of equipment and employees' hands to verify that equipment hygiene and personal hygiene are correct (f). Absence of bacteria (e) swab and rotation of equipment and employees' hands to verify that equipment hygiene and personal hygiene are correct (f).


**Figure 2**. Images from the photographic report, refer to the mitigating actions of risks. Thermohygrometer for checking temperature and humidity (a), impactor for analysis of fungi and bacteria from the air (b), mixer Swab (c), the attire of workers' (d), water analysis (e), Swab and wheel of equipment and workers' hands (f).

## 4 Conclusions

The assessment of environmental risks through the PRA matrix is essential for managing health and safety at work in a center for handling enteral diets. With this data, it is possible to develop measures and actions to control risks, improve the work environment and guarantee the health and safety of workers.

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